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REPORT
OF THE
JOINT COMMISSION
RELATIVE TO THE
PRESERVATION OF THE FISHERIES IN WATERS CONTIGUOUS
TO
CANADA AND THE UNITED STATES

(Submitted December 31, 1896)

PRINTED BY ORDER OF PARLIAMENT



OTTAWA

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EXCELLENT MAJESTY

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CORRESPONDENCE

RELATIVE TO

APPOINTMENT OF JOINT COMMISSION

Mr. Foster to Mr. Herbert.

DEPARTMENT OF STATE,
WASHINGTON, October 4, 1892.

SIR,—As the result of our several recent conferences on the subject of giving effect to so much of the understanding reached in concert by the Secretary of State and the delegates of the government of the Dominion of Canada on February 15 last, as relates to the prevention of destructive methods of fishing in the contiguous waters of the United States and Canada, and the preservation of the fisheries thereof, I have now the honour to submit the views of this government in the matter, to the end of reaching a formal agreement thereon.

The proposition of February 15, 1892, in this regard was that a commission of two experts should be appointed—one by the Government of the United States and one by the Government of Great Britain—to consider and report to their respective governments, either jointly or severally, as to the restrictions and regulations which should be adopted on the following subjects:

- (1) The prevention of destructive methods of fishing in the territorial and contiguous waters of the United States and Canada, respectively, and also in waters outside the territorial limits of either country.
- (2) The prevention of the polluting and obstructing of such contiguous waters to the detriment of fisheries and navigation.
- (3) The close seasons which should be enforced and observed in such waters by the inhabitants of both countries; and
- (4) On the subject of restocking and replenishing such contiguous waters with fish ova and the means by which fish life may be therein preserved and increased.

I deem it convenient thus to quote in full the text of the tentative understanding of the general scope and direction of the inquiries to be jointly set on foot, and as the groundwork upon which to essay a fuller and more precise international agreement.

The several lines of inquiry having relation to the different aspects, whether general or particular, of the questions so presented fall, as far as this government is concerned, within the purview of the operations conducted for a number of years past by the United States Commission of Fish and Fisheries, which, in its investigations, and in the practical application of its methods and making use of the extensive establishment and ample means appropriated by Congress, has massed a stock of information, much of which may be found available for the purpose of investigation and recommendation for which the joint commission is proposed to be organized. I am advised that the United States Fish Commission has within itself the resources in men and means to conduct such further inquiries in relation to the

statistics, methods and condition of the fisheries in question as the joint commission, or the American representative thereon may indicate as desirable for their information.

A similar fish commission is understood to exist in the Dominion of Canada, and to have pursued like valuable investigations and practical operations for a number of years past.

The necessary machinery and a large part of the data for the proposed joint investigation appear, therefore, to be already at the command of the Government of the United States and Her Britannic Majesty's Government without the necessity for creating other or independent legislative appropriation. As the subject is to arrive by convention or coincident legislative appropriation. As the subject is to arrive at such concurrent recommendations as may commend themselves to the good judgment of the respective governments and open the way, in case of accord thereon, for a formal conventional agreement in promotion of the mutual interests of their respective citizens and subjects as regards their equal and common benefit in the conservation of food-fishes in the territorial and contiguous waters of the United States and Her Britannic Majesty's possessions in North America, it seems most desirable for the two parties to avail themselves in common, so far as may be practicable, of the means already at hand in order that the end in view may be the more speedily attained.

That this may be conveniently accomplished, I have the honour to propose for the consideration of Her Britannic Majesty's Government the following bases for an agreement to be reached by diplomatic exchange of notes:

I. The Governments of the United States of America and of Her Majesty the Queen of the United Kingdom of Great Britain and Ireland agree that a commission of two experts shall be appointed, one on behalf of each government—either jointly or severally, or jointly to both governments, with regard to matters in which they may be in accord, and severally to their respective governments with regard to matters of non-concurrence—concerning the regulations, practice, and restrictions proper to be adopted in concert, on the following subjects, viz.:

(a.) The limitation or prevention of exhaustive or destructive methods of taking fish or shellfish in the territorial and contiguous waters of the United States and Her Majesty's possessions in North America, respectively, and also in the waters of the open seas outside the territorial limits of either country to which the inhabitants of the respective countries may habitually resort for the purpose of such fishing.

(b.) The prevention of the polluting or obstructing of such contiguous waters to the detriment of the fisheries or of navigation.

(c.) The close seasons expedient to be enforced or observed in such contiguous waters by the inhabitants of both countries as respects the taking of the several kinds of fish and shellfish.

(d.) The adoption of practical methods of restocking and replenishing such contiguous and territorial waters with fish and shellfish, and the means by which such fish life may be therein preserved and increased.

II. The commissioners to be so appointed shall meet at the city of Washington within three months from the date of this present agreement, and shall complete their investigation and submit their final reports thereof to the two governments as herein provided, within two years from the date of their first meeting.

III. The contracting governments agree to place at the service of the said commissioners all information and material pertinent to the subjects of their investigation which may be of record, respectively, in offices of the United States Commission of Fish and Fisheries, and in the Department of Marine and Fisheries of the Dominion of Canada; and further, to place at the disposal of said commissioners, acting jointly, any vessel or vessels of either of said fish commissions of the United States and of Canada as may be convenient and proper, to aid in the prosecution of their investigation in the contiguous or adjacent waters aforesaid.

It is further agreed that, if required by either or both of the said commissioners, a competent employee of either or both of the said fish commissions of the

United States and of Canada shall be detailed to assist the said commissioners in the preparation of their reports.

IV. Each government will defray the expenses of its commissioner, and of such employee as may be detailed to assist him, as provided in the preceding section.

V. The two governments agree that so soon as the reports of the commissioners shall be laid before them, as aforesaid, they will consider the same and exchange views thereon, to the end of reaching, if expedient and practicable, such conventional or other understanding as may suffice to carry out the recommendations of the commissioners, by treaty, or concurrent legislation on the part of the respective governments or the legislatures of the several states and provinces, or both, as may be found most advisable, but nothing herein contained shall be deemed to commit either government to the results of the investigation hereby instituted.

I beg that you will submit the foregoing draft of an agreement to Her Britannic Majesty's Government for consideration, with the limitation that, if it be accepted, this government will be prepared forthwith, for its part, to give full force and effect from the date when such acceptance may be notified to it.

I have, etc.,

JOHN W. FOSTER.

Mr. Herbert to Mr. Foster.

BRITISH LEGATION, October 6, 1892.

SIR,—I have the honour to acknowledge receipt of your note of the 4th instant, submitting a draft agreement in regard to the preservation of the fisheries in the waters contiguous to Canada and the United States, and to inform you that I have sent copies of this communication to the Earl of Rosebery and the Governor General of Canada.

I have the honour to be, with the highest consideration, sir,
Your most obedient, humble servant,

MICHAEL H. HERBERT.

Sir Julian Pauncefote to Mr. Foster.

BRITISH LEGATION, December 5, 1892.

SIR,—I have the honour to inform you that the draft agreement for the preservation of the fisheries in the waters contiguous to Canada and the United States, proposed in your note of the 4th October last, was duly submitted to the Canadian Government, and I have now received a dispatch from the Governor General, in which His Excellency states that the terms of the agreement are acceptable to his government, as appears from an approved minute of council, of which I have the honour to inclose a copy.

I have the honour to be, with the highest consideration, sir,
Your most obedient, humble servant,

JULIAN PAUNCEFOTE.

[1514 H.]

Certified copy of a report of a committee of the Honourable the Privy Council, approved by His Excellency the Governor General in Council, on the 31st October, 1892.

The Committee of the Privy Council have had under consideration a despatch, hereto attached, dated 6th October, 1892, from Her Majesty's representative at Washington, covering a communication from the United States Secretary of State, dated 4th October, 1892, to Mr. Herbert, resulting from several conferences on the subject of giving effect to so much of the understanding reached by the United States Secretary of State and the delegates from the Government of Canada, on 15th February last, as relates to the prevention of destructive methods of fishing in the contiguous waters of the United States and Canada and in other waters, and the preservation of the fisheries thereof, and with the object of reaching a formal agreement, the Secretary of State submits the views of his government.

The Minister of Marine and Fisheries, to whom the question was referred, observes that the proposition of 15th February, 1892, is referred to as the appointment of a commission of two experts, one by each government, to consider and report, either jointly or severally, as to the restrictions and regulations on the following subjects, namely:

- 1st. "The prevention of destructive methods of fishing in the territorial and contiguous waters of the United States and Canada, respectively, and also in waters outside the territorial limits of either country."
- 2nd. "The prevention of the polluting and obstruction of such contiguous waters to the detriment of fisheries and navigation."
- 3rd. "The close seasons which should be enforced and observed in such waters by the inhabitants of both countries;" and
- 4th. "On the subject of restocking and replenishing such contiguous waters with fish ova, and the means by which fish life may be therein preserved and increased."

He therefore proposed certain bases for an agreement to be reached by a diplomatic exchange of notes:

"I. The Governments of the United States of America and of Her Majesty the Queen of the United Kingdom of Great Britain and Ireland agree that a commission of two experts shall be appointed, one on behalf of each government, to consider and report to their respective governments, either jointly or severally, or jointly to both governments, with regard to matters in which they may be in accord, and severally to their respective governments with regard to matters of non-concurrence concerning the regulations, practice, and restrictions proper to be adopted in concert on the following subjects:

"(a) The limitation or prevention of exhaustive or destructive methods of taking fish and shellfish in the territorial and contiguous waters of the United States and Her Majesty's possessions in North America, respectively, and also in the waters of the open seas outside the territorial limits of either country to which the inhabitants of the respective countries may habitually resort for the purpose of such fishing;

"(b) The prevention of the polluting or obstructing of such contiguous waters to the detriment of the fisheries or of navigation;

"(c) The close seasons expedient to be enforced and observed in such contiguous waters by the inhabitants of both countries as respects the taking of the several kinds of fish and shellfish.

"(d) The adoption of practical methods of restocking and replenishing such contiguous and territorial waters with fish and shellfish, and the means by which such fish life may be therein preserved and increased.

"II. The commissioners to be appointed shall meet in the city of Washington within three months from the date of this present agreement and shall complete their investigations and submit their final reports thereof to the two governments, as herein provided, within two years from the date of their first meeting.

"III. The contracting governments agree to place at the service of the said commissioners all information and material pertinent to the subjects of their investigations which may be of record, respectively, in the offices of the United States Commission of Fish and Fisheries and in the Department of Marine and Fisheries of the Dominion of Canada, and further, to place at the disposal of said commissioners, acting jointly, any vessel or vessels of either of said fish commissions of the United States and Canada as may be convenient and proper to aid in the prosecution of their investigation in the contiguous or adjacent waters aforesaid.

"It is further agreed that, if required by either or both of the said commissioners, a competent employee of either or both of the said fish commissions of the United States and of Canada shall be detailed to assist the said commissioners in the preparation of their reports.

"IV. Each government shall defray the expenses of its commissioner and of such employee as may be detailed to assist him as provided in the preceding section.

"V. The two governments agree that so soon as the reports of the commissioners shall be laid before them as aforesaid, they will consider the same and exchange views thereon, to the end of reaching, if expedient and practicable, such conventional or other understanding as may suffice to carry out the recommendations of the commissioners by treaty or concurrent legislation on the part

of the respective governments, or the legislatures of the several states and provinces, or both, as may be found most advisable; but nothing herein shall be deemed to commit either government to the results of the investigation hereby instituted."

The Minister of Marine and Fisheries reports that although the information at the command of the Canadian Government may not be so complete as that connected with the long-established Fish Commission of the United States, important material has been collected by the Department of Marine and Fisheries, and that conferences between the experts proposed to investigate and deal with the subjects, will, no doubt, lead to a full possession of the main facts connected with the fisheries in which the two countries are so much interested.

The minister therefore reports to Your Excellency that the terms of the draft agreement as submitted by the Secretary of State for the United States are acceptable.

The committee advise that Your Excellency be moved to transmit a copy of this minute to Her Majesty's representative at Washington for his information.

All of which is respectfully submitted for Your Excellency's approval.

JOHN J. MCGEE,

Clerk of the Privy Council.

Mr. Herbert to Lord Stanley of Preston.

[No. 89.]

WASHINGTON, October 6, 1892.

MY LORD,—With reference to my dispatch, No. 79, of the 13th ultimo, I have the honour to inclose a copy of a note which I have received from Mr. Foster submitting the draft of an agreement which he suggests should be effected by an exchange of notes in regard to the preservation of the fisheries in the waters contiguous to the United States and Canada.

Mr. Foster told me a few days ago that he thought, for the reasons which he has repeated in this note, that a convention was unnecessary at the present moment, and that his proposal as to the form of agreement to be reached would be simpler and more expeditious.

I have, etc.,

MICHAEL HERBERT.

Mr. Foster to Sir Julian Pauncefote.

DEPARTMENT OF STATE,

WASHINGTON, December 6, 1892.

SIR,—I have the honour to acknowledge the receipt to-day of your note of the 5th instant, by which you inform me that the Canadian Government has accepted the draft agreement for the preservation of the fisheries in the waters contiguous to Canada and the United States, proposed in my note to Mr. Herbert, October 4 last.

This reply consequently completes the agreement by exchange of notes as proposed by my communication on the 4th of October last, and fixes this day as the date of the agreement.

I have much pleasure in giving immediate effect to this agreement as far as depends upon the executive power, by informing you that the President has appointed as the representative expert of the United States for the purpose of the stipulated joint investigation, Mr. Richard Rathbun, of the United States Fish Commission.

I beg that you will advise me of the name of the expert to be appointed on behalf of Her Majesty's Government, in order that Mr. Rathbun may be instructed

MARINE AND FISHERIES.

to confer with his Canadian colleague as to the time of meeting and plan of operations.

I have the honour to be, with the highest consideration, sir,
Your obedient servant,

JOHN W. FOSTER.

Mr. Foster to the Commissioner of Fish and Fisheries.

DEPARTMENT OF STATE,

WASHINGTON, December 8, 1892.

SIR,—I have the honour to inclose for your information copies of correspondence between this department and the British chargé at this capital, relative to a draft agreement for the preservation of the fisheries in the waters contiguous to Canada and the United States, which was submitted by this department for the consideration of that government by my note of the 4th of October last to Mr. Herbert, chargé, etc.

You will observe that my note of the 6th instant to the British Minister completed the agreement by exchange of notes, and that thereby that day is fixed as the date of the agreement.

The department now awaits information as to the name of the Canadian representative expert. As soon as that information is received from the British Minister it will be communicated to you, in order that Mr. Rathbun may, without delay, confer with his Canadian colleague as to the time of meeting and plan of operations.

I have the honour to be, sir, your obedient servant,

JOHN W. FOSTER.

Mr. Rathbun to Mr. Gresham.

UNITED STATES COMMISSION OF FISH AND FISHERIES,

WASHINGTON, D.C., December 22, 1894.

SIR,—Referring to the agreement of December 5, 1892, for the preservation of the fisheries in the waters contiguous to Canada and the United States, I have the honour to report as follows upon the progress made in the inquiries relative thereto, and to ask your consideration of the question of extending the time for the completion of the work.

As provided by the agreement, the representatives designated on the part of the two governments, Great Britain and the United States, met in Washington on the 2nd day of March, 1893, at which time, after a conference at the State Department, the investigations necessary to secure the required information as a basis for the recommendations desired were determined upon, and plans were made for the conduct of the same.

The regions covered by the agreement in question were designated to be "the territorial and contiguous waters of the United States and Her Majesty's possessions in North America, respectively, and also the waters of the open seas outside of the territorial limits of either country to which the inhabitants of the respective countries may habitually resort for the purpose of such fishing."

These waters were interpreted by the representatives to include the following, namely:

The Atlantic sea coast between Cape Hatteras and the mouth of the River St. Lawrence, in respect to the mackerel fishery;

The Bay of Fundy;

The St. John and St. Croix Rivers between New Brunswick and the state of Maine;

Lake Memphremagog and Lake Champlain;

The great lake system;

Lake of the Woods, and all other fresh-water lakes and streams along the northern border between Lake Superior and the Pacific Coast; and

The salt waters lying between the state of Washington and British Columbia.

The field investigations were started early in the spring of 1893 and have been actively prosecuted up to the present time at all seasons when the weather has been suitable. The United States Commissioner of Fish and Fisheries has placed at our service the several vessels of the fish commission, and such other means at his disposal as could be utilized in this connection, and no pains have been spared to make the inquiries as thorough and exhaustive as the time would permit.

During 1893 the work related to the mackerel fishery along the Atlantic sea-coast, and the fisheries of the Bay of Fundy, the Rivers St. John, St. Croix and St. Lawrence, and the northern shores of Lakes Ontario and Erie. At the close of that season it became evident that the investigations could not be completed satisfactorily within the limit of time fixed by the agreement, namely, March 2, 1895, and I suggested to my colleague, the British representative, Dr. William Wakeham, that an extension of time should be requested. The attention of the Minister of Marine and Fisheries of Canada having been called to this matter, the latter expressed a desire that a report upon the fisheries of the great lakes be submitted in accordance with the terms of the agreement, but interposed no objection to further delay in respect to the other waters.

Feeling confident that such an arrangement would not be unfavourably regarded by this government, the past season has been occupied chiefly in making an investigation of the fisheries of the great lakes, which has been completed only within a few weeks. These inquiries have been conducted on a scale far exceeding any of a similar nature heretofore undertaken, and the amount of material secured in the way of field notes and stenographic testimony is much greater than had been anticipated. I am firmly convinced that it will be impossible to properly condense this information and to prepare a conclusive or satisfactory report upon the subject by the 2nd of next March.

In respect to this matter, Dr. Wakeham also agrees with me, and I beg to state that, in a letter recently received from him, he informs me that a proposition to extend the time for submitting the report relative to the great lakes would be considered favourably by the Canadian Government.

The two representatives feel confident of their ability to complete the work with respect to the great lakes by June 1, 1895, three months subsequent to the date based upon the agreement, but for the remainder of the region covered by the agreement at least another year (or until June, 1896) will be required, owing to the fact that sufficient field work remains to be done to occupy an entire season.

In view of the facts set forth, and also by reason of the extent and value of the industries that may be affected thereby, I feel constrained most respectfully to urge that the dates for submitting the reports of the commission be changed to those before indicated.

I have the honour to be, very respectfully, your obedient servant,

RICHARD RATHBUN,

Representative on the Part of the United States.

Forwarded.

HERBERT A. GILL,

Acting Commissioner.

Mr. Gresham to Sir Julian Pauncefote.

DEPARTMENT OF STATE,
Washington, December 31, 1894.

EXCELLENCY,—Referring to previous correspondence relative to measures for the preservation of the fisheries in the waters contiguous to the United States and Canada, I have the honour to inclose, for the consideration of Her Britannic Majesty's Government, a copy of a communication dated the 22nd instant, from the representative of the United States on the joint commission on the subject in question, under the agreement of December 6, 1892, suggesting an extension of the time for the preliminary investigations of the Commission until June 1, 1896, in order that the unfinished work which extends from the great lakes to the Pacific Coast may be completed.

I beg to say that this department fully approves of the suggestion for an extension of time made by Mr. Rathbun, and, if agreeable to your Government, would be pleased to carry the proposed arrangement into effect by an exchange of notes on the basis of the present agreement.

I have the honour to be, with the highest consideration, Mr. Ambassador,

Your most obedient servant,

W. Q. GRESHAM.

Mr. Gresham to Mr. Rathbun.

DEPARTMENT OF STATE,
Washington, December 31, 1894.

SIR,—I have to acknowledge the receipt of your letter of the 22nd instant, suggesting the advisability of extending the time for the completion of the work of the commission for the preservation of fisheries until June 1, 1896, and to inform you that the department has called the matter to the attention of the British embassy with a view to carrying the proposed arrangement into effect by an exchange of notes.

I am, etc.,

W. Q. GRESHAM.

RICHARD RATHBUN, Esq.,

*Representative on the Part of the United States on the
Joint Commission for the Preservation of Fisheries, etc.*

Sir Julian Pauncefote to Mr. Gresham.

WASHINGTON, February 22, 1895. (Received Mar. 4.)

SIR,—I have the honour to inform you that I lost no time in referring to the Earl of Kimberley your note of December 31 last, respecting the joint commission for the investigation of the fisheries in the waters contiguous to the United States and Canada.

I am now instructed to state that Her Majesty's Government has no objection to offer to the suggestion to extend the time for the preliminary investigation until

June 1, 1896, and I am accordingly authorized to carry the arrangement into effect by an exchange of notes as proposed in your note under reply.

I have, etc.,

JULIAN PAUNCEFOTE.

Mr. Gresham to Sir Julian Pauncefote.

No 44.]

DEPARTMENT OF STATE,

Washington, March 2, 1895.

EXCELLENCY,—I have the honour to acknowledge receipt of your note of the 22nd ultimo, which only reached this department to-day, informing me that Her Majesty's Government accepts the proposition contained in my note of December 31, 1894, for an extension of time for the preliminary investigation of the fisheries in the waters contiguous to the United States and Canada until June 1, 1896.

In accordance with the concluding paragraph of that note, this action of Her Majesty's Government is accepted as carrying the recent agreement into effect by an exchange of notes.

I have, etc.,

W. Q. GRESHAM.

Mr. Adee to Mr. Rathbun.

DEPARTMENT OF STATE,

Washington, April 12, 1895.

SIR,—In connection with your letter of December 22, 1894, and the department's reply of the 31st of that month, I herewith transmit for your information a copy of a note from the British ambassador of February 22, 1895, assenting to the proposition of this department that the time for the completion of the work of the joint commission for the preservation of the fisheries in the waters contiguous to the United States and Canada be extended until June 1, 1896, by an exchange of notes.

I am sir, your obedient servant,

ALVEY A. ADEE,

Acting Secretary.

Mr. Rathbun to Mr. Olney.

UNITED STATES COMMISSION OF FISH AND FISHERIES.

Washington, D.C., April 6, 1896.

SIR,—I have the honour to bring to your attention the inquiries which are being conducted in accordance with the provisions of the agreement of December 6, 1892, between the United States and Great Britain for the preservation of the fisheries in the waters contiguous to Canada and the United States, and to request consideration of the question of extending the time in which that work shall be completed.

The representatives on the part of the two governments had their first meeting in Washington on the 2nd day of March, 1893, and by the terms of the agreement

they were to submit their report within two years from that date. As it was found impossible, however, even to complete the field investigations within that period, the time was extended by an exchange of notes, to the 1st of June, 1896. The field work was practically finished last fall, and during the past winter each of the representatives was engaged, in so far as his other official duties permitted, in arranging and reviewing the notes taken preliminary to the final meeting and preparation of the report.

The British representative, Dr. William Wakeham, arrived in Washington for the latter purpose on the 1st of March last, when the joint consideration of the testimony which had been collected was immediately taken up. After a month's time spent in examining and condensing this material, however, we find that the subject is much more extensive and complex than had been supposed, and we have become convinced that full justice can not be done it in the period now remaining. Not only have we to consider and reconcile the conflicting statements contained in the large amount of testimony and notes secured by ourselves, covering over 15,000 typewritten pages, but it is also necessary to consult the published records of both governments bearing upon the same questions, which date back many years, and to study, in respect to their application to the requirements of the boundary fisheries, the different systems of fishery legislation now or hitherto in force in this and other countries.

In view of the extent and importance of the interest which may be affected by our conclusions, and also of the fact that our report could not be taken into consideration either by the Congress of the United States or by the Canadian Parliament before that time, I would, therefore, respectfully urge that the date for submitting the report of the commission be changed to December 30, 1896.

The British representative, Dr. William Wakeham, is in accord with me in regard to this matter, and will so advise his government.

I have the honour to be, very respectfully, your obedient servant,

RICHARD RATHBUN,
Representative on the part of the United States.

Mr. Olney to Sir Julian Pauncefote

DEPARTMENT OF STATE,

Washington, April 7, 1896.

EXCELLENCY,—Referring to previous correspondence relative to measures for the preservation of the fisheries in the waters contiguous to the United States and Canada, and particularly to Mr. Gresham's notes of the 31st December, 1894, and March 2, 1895, and the replies of your embassy thereto, dated February 22, 1895, and March 2, 1895, I have the honour to inclose for the consideration of Her Britannic Majesty's Government a copy of a letter, dated the 6th instant, from the representative of the United States on the joint commission on the subject in question, under the agreement of December 6, 1892, suggesting an extension of the time for the investigations of the commission from June 1 until December 30, 1896, to enable the Commission to complete its work, which has been found to be more extensive than was anticipated.

I beg to say that this department fully approves of the suggestion for an extension of time made by Mr. Rathbun, and, if agreeable to your government, would be pleased to carry the proposed arrangement into effect by an exchange of notes on the basis of the present agreement.

I have the honour to be, with the highest consideration, Mr. Ambassador,
Your most obedient servant,

RICHARD OLNEY.

Sir Julian Pauncefote to Mr. Olney.

WASHINGTON, April 11, 1896.

SIR,—I have the honour to acknowledge the receipt of your note, No. 362, of the 7th instant, suggesting an extension of time for the investigations of the commission appointed to inquire into the measures to be taken for the preservation of the fisheries in the waters contiguous to the United States and Canada.

I have not failed to bring your proposal to the notice of Her Majesty's principal Secretary of State.

I have the honour to be, with the highest consideration, sir,

Your most obedient, humble servant,

JULIAN PAUNCEFOTE.

Mr. Olney to Sir Julian Pauncefote.

DEPARTMENT OF STATE,

WASHINGTON, May 30, 1896.

EXCELLENCY,—With reference to previous correspondence concerning the proposal for the extension from the 1st of June to the 31st of December, 1896, of the time limited for the completion of the report of the joint commission under the agreement between the United States of America and Great Britain, of December 6, 1892, for the preservation of the fisheries in the waters contiguous to the United States and Canada, I have the honour to acknowledge the receipt of your note of to-day in which you notify me of the assent of Her Majesty's Government to the extension of time proposed in my note to you of the 7th of April last.

This consequently completes the agreement in question by an exchange of notes.

I have the honour to be, with the highest consideration, Mr. Ambassador,

Your most obedient servant,

RICHARD OLNEY.

Sir Julian Pauncefote to Mr. Olney.

WASHINGTON, May 30, 1896.

SIR,—In reply to your note of the 27th instant, I have the honour to inform you that I am duly authorized by Her Majesty's Government to assent, and do hereby assent on their behalf, to the proposal, contained in your note of the 7th ultimo, for the extension from the 1st of June to the 31st of December, 1896, of the time limited for the completion of the report of the joint commission under the agreement between Great Britain and the United States, of December 6th, 1892, for the preservation of the fisheries in the waters contiguous to Canada and the United States.

I have the honour to be, with the highest consideration, sir,

Your most obedient, humble servant,

JULIAN PAUNCEFOTE.

MARINE AND FISHERIES.

Mr. Olney to Mr. Rathbun.

DEPARTMENT OF STATE,

WASHINGTON, June 1, 1896.

SIR,—Referring to your letter of the 6th of April last, relative to the necessity for extending the time for the completion of the work of the American and British commission to devise measures for the preservation of the fisheries of the waters contiguous to the United States and the Dominion of Canada, I inclose for your information a copy of the correspondence by which an agreement has been concluded by an exchange of notes for an extension of the time for the completion of the work of the commission from June 1 to December 31, 1896.

I am, sir, your obedient servant,

RICHARD OLNEY.

Mr. Wakeham to Minister of Marine and Fisheries.

OTTAWA, CANADA, December 31, 1896.

SIR,—I have the honour to submit herewith the report of the joint commission relative to the preservation of the fisheries in waters contiguous to Canada and the United States, as provided by the joint agreement between Great Britain and the United States under date of December 6, 1892.

I have the honour to be, very respectfully, your obedient servant,

WM. WAKEHAM,

Representative on behalf of Great Britain.

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REPORT
OF THE
JOINT COMMISSION

RELATIVE TO THE PRESERVATION OF THE FISHERIES IN WATERS
CONTIGUOUS TO CANADA AND THE UNITED STATES.

An agreement having been entered into between the government of Great Britain and that of the United States of America, under date of December 6, 1892, providing for the appointment of a commission of two experts, one on behalf of each government, "to consider and report to their respective governments, either jointly or severally, or jointly to both governments with regard to matters in which they may be in accord, and severally to their respective governments with regard to matters of non-concurrence, concerning the regulations, practice and restrictions proper to be adopted in concert, on the following subjects, viz.:-

"1. The limitation or prevention of exhaustive or destructive methods of taking fish and shell-fish in the territorial and contiguous waters of the United States and Her Majesty's possessions in North America respectively, and also in the waters of the open seas outside of the territorial limits of either country to which the inhabitants of the respective countries may habitually resort for the purpose of such fishing.

"2. The prevention of the polluting or obstructing of such contiguous waters to the detriment of the fisheries or of navigation.

"3. The close seasons expedient to be enforced and observed in such contiguous waters by the inhabitants of both countries as respects the taking of the several kinds of fish and shell-fish.

"4. The adoption of practical methods of restocking and replenishing such contiguous and territorial waters with fish and shell-fish, and the means by which such fish life may be therein preserved and increased.

"The commissioners to be appointed shall meet at the city of Washington within three months from the date of this present agreement, and shall complete their investigation and submit their final reports thereof, to the two governments as herein provided, within two years from the date of their first meeting."

And the undersigned having been duly commissioned by their respective governments, in accordance with the above agreement, and having communicated to each other their respective powers, found to be in due and proper form, have agreed to the following report :-

The first meeting of the commission was held at Washington, beginning on the 2nd of March, 1893, at which an understanding was reached respecting the scope and conduct of the inquiries necessary to be made. Owing, however, to the extent of the waters requiring examination, it was found impracticable to complete the work within the limit of time specified, and the same was accordingly extended, by an exchange of notes between the two governments, to the 31st of December, 1896.

The following fisheries were considered to be covered by the terms of the agreement, namely: The mackerel fisheries of the Atlantic sea coast and the Gulf of St. Lawrence, and the fisheries in general in the boundary and contiguous waters as follows: Passamaquoddy Bay and adjacent waters, and the St. John and St. Croix

Rivers, situated between the province of New Brunswick and the state of Maine; Lake Memphremagog, between the province of Quebec and the state of Vermont; Lake Champlain, between the province of Quebec and the states of Vermont and New York, the upper part of the St. Lawrence River and the chain of the Great Lakes, between the province of Ontario and the border states from New York to Minnesota inclusive; Rainy Lake and River and Lake of the Woods, between the provinces of Ontario and Manitoba and the state of Minnesota; the Columbia River, which crosses the international boundary line from British Columbia into the state of Washington; the Fraser River, Gulf of Georgia, Puget Sound and Strait of Juan de Fuca, contiguous to British Columbia and the state of Washington.

All of the waters above named, except Rainy Lake and the Columbia River, have been visited by the two representatives conjointly, who have carried on such detailed investigations respecting the fisheries and fishery resources of each of them as the time and means at their disposal have permitted. Additional information has been obtained through the observations of several naturalists and fishery experts, who have been detailed from time to time to the study of the same waters, and use has been made of such records belonging to the Department of Marine and Fisheries of Canada and the United States Fish Commission as relate to the several subjects in question.

The conditions which the commission has found to exist and the conclusions which it has reached are presented under the several headings which follow.

On account of the diversified characteristics of the waters investigated, the variety of their products and the magnitude of the industries to which the latter give rise, we have found it impossible to consider fully all the questions which the subject presents, and have, therefore, been unable in many cases to reach more than general conclusions, leaving the matter of details to be settled by further and more complete inquiries. Our observations, moreover, have clearly demonstrated the inexpediency of attempting to regulate any of the fisheries herein discussed by a rigid code of enactments, owing to their constantly changing character and conditions, and we would therefore urge, in the event of joint action by the two governments, that a permanent joint commission, to be composed of competent experts, be provided for, which shall be charged with the direct supervision of these fisheries, and shall be empowered to conduct the necessary investigations, and to institute such modifications in the regulations as the circumstances may call for from time to time.

That a uniform system of regulations common to the entire extent of each body of water along the boundary line is required to insure the protection of its resources, is fully shown by the conditions which we have found to exist in nearly all of them, whether bordered on the side of the United States by a single state or by several states. The failure to secure adequate results in that direction has, naturally, been due to the diversity of legislation, but it has resulted in large part from the general lack of accurate information regarding the habits of the several fishes to serve as a basis for intelligent action. While we have been able to establish some important facts respecting the natural history of the commoner market species, much more remains to be accomplished in that regard, and the subject should be given due prominence in the future.

All questions, outside of navigation, with which we have had to deal have been considered solely from the standpoint of the preservation of the several fisheries, and we have endeavoured in each instance to provide for the most liberal amount of fishing, which, in our judgment, was warranted by the circumstances. In so doing we have been led to suggest greater license in some regions than is granted by existing laws, but wherever a state on the one side or the Dominion government on the other would impose greater strictures than are here recommended, we see no objection thereto.

We are convinced that no system of regulations can be properly administered except by the registration or licensing of the fishermen, as a basis for restricting the character and amount of apparatus employed in each locality, while, on the

other hand, we feel confident that the fishermen themselves would be greatly benefited by such a measure, through the protection of individual rights thereby assured to them.

Much of the irritation occasioned from time to time, especially in the region of the Great Lakes, through the fishermen of one country extending their operations into the territory of the other, has undoubtedly resulted from the imperfect knowledge which prevails respecting the relations of the intervening water areas. In fact, the belief is wide-spread that wherever the lakes exceed six miles in width each country has jurisdiction only to a distance of three miles from its shores, leaving a neutral area or high sea between, to which the fishermen from both sides are privileged to resort in common. On the official maps of the Great Lakes the boundary line is not shown, nor can its position be accurately marked in most places until new surveys shall be made conjointly by the two governments. It would be greatly to the advantage of the fishing interests in that region, and much annoyance would be prevented in the future, by having the boundary line re-defined and appropriately located on a series of charts made available for distribution among the fishermen.

Very extensive investigations have been made respecting the mackerel and mackerel fisheries throughout the entire extent of the range of that species, the same having been continued during each of the four seasons which have elapsed since the date of the agreement. As it has been impossible, however, to give proper consideration to the large amount of testimony collected in that connection, we have been unable to incorporate the subject in this report.

ST. JOHN RIVER SYSTEM.

THE RIVER SYSTEM DEFINED.

Of the two streams which unite to form the St. John River in the north-western part of Maine, the so-called south-west or boundary branch lies mostly between the State of Maine and the Province of Quebec, while on the north, eastward of the meridian of about 69 degrees 15 minutes west, the same state is separated from the provinces of Quebec and New Brunswick by the main river and its northern tributary, the St. Francis. After leaving this part of the boundary line the St. John River belongs wholly in New Brunswick, but three of its larger lower tributaries, the Aroostook, Big Presque Isle and Meduxniekeag rivers, have their origin in Maine. At Grand Falls, only a few miles below the north-eastern corner of the state, the main river makes an abrupt descent of about sixty feet, which serves as a barrier to the ascent of all fishes, and practically divides the river into two parts, having quite different characteristics in respect to fishery matters; they may be designated as the upper and lower courses of the river.

International Interests.—In the lower St. John River international interests relate chiefly to such anadromous fishes as, under natural conditions, would ascend the tributary streams into the state of Maine; there as well as in the upper river the trout and possibly other species also merit joint protection.

(Important Fishes.)

Anadromous species.—The main river below Grand Falls contains no natural or artificial barriers to the ascent of anadromous fishes, of which the salmon (*Salmo salar*), shad (*Alosa sapidissima*), alewife (*Pomolobus pseudoharengus*), sturgeon (*Acipenser sturio*), smelt (*Osmerus mordax*), and striped bass (*Morone saxatilis*) belong in this region. The only species, however, which are known to have made their way up the western tributaries into Maine are the salmon and the alewife.

Salmon.—The salmon ascend the St. John River as far as Grand Falls and formerly had their spawning grounds in many of its tributary streams on both sides, but the most of these have been closed against them to a greater or less extent. The Tobique, a clear, cold and rapid river which enters from the east about twenty miles below Grand Falls, is the principal salmon stream at present as it has probably always been. The fishing privileges are now leased by the provincial government, and great pains are taken to insure the preservation of its natural features. Other exclusively provincial affluents to which the salmon are said to have resorted more or less abundantly at one time, but in which they now appear only sparingly or not at all, owing to obstructions, pollutions or insufficient protection, are the Nashwaak, Oromocto, Canaan, Kennebecasis and the two salmon rivers.

The Meduxnieag River, the lowest of the international tributaries, joins the St. John River at Woodstock, N.B., and consists mainly of two principal branches of nearly equal size, which unite about twelve miles above its mouth and only a few miles east of the boundary line. Its drainage area, comprising about 420 square miles, is situated mostly within the State of Maine, in close proximity to the eastern border. Authentic records show that during the early part of this century salmon entered this river in abundance, having been observed more especially in the vicinity of Houlton, Me., where they continued plentiful until shut out by dams about 1826. During some years, however, it is reported that a few salmon still find their way into the lower part of the river.

The Big Presque Isle River is naturally a clear and rapid stream, about forty miles long, which traverses five or six townships in the extreme eastern part of Maine, between the Meduxnieag and Aroostook valleys, and reaches the St. John River a few miles below Florenceville, N. B. It was formerly resorted to by salmon, but to what extent it has been impossible to ascertain.

The Aroostook River, which empties into the St. John River about six miles above the town of Andover and sixteen miles below Grand Falls, is the largest tributary of this system, having a length of 138 miles and a drainage area of 2,160 square miles. Only the last four miles of its course are in New Brunswick. It has numerous tributaries and some lakes. Its waters are mainly tranquil to near the boundary line, where a series of rapids begins, the river finally entering a gorge in which there are five principal cascades with an aggregate descent of 75 feet, the largest being a fall about 16 feet high. Within the gorge the waters are very turbulent, and in the three miles below it, to the mouth, there are several rough rapids.

Although the fall above mentioned constitutes a serious impediment to the passage of salmon, it is not insurmountable, and a considerable run seems to take place every year. While making the ascent they are said to accumulate in a broad basin at the foot of the fall, and to find a resting place in a small pool farther up. They have been observed a hundred miles up the river, and are captured at many places along its course. The building of a dam across the main river at Caribou, in 1888, interposing an obstruction to their movements, has made their presence conspicuous in that locality, and shown them to be much more plentiful than had been supposed. Reliable information respecting the amount of salmon taken annually from the Aroostook River is not obtainable, as the fishing is carried on only by sportsmen and poachers, but many relatively large catches are reported from time to time. The species was undoubtedly much more abundant in early times than it is at present, as many, if not most, of the tributary streams containing the original spawning grounds are now closed by dams or encumbered with refuse. That some spawning places are still accessible, however, is indicated by the continued presence of the salmon in the river.

Alewives.—Alewives formerly entered the Meduxnieag River and were shut out from it by the same agencies that interrupted the ascent of salmon, but we have not been able to learn of their occurrence in either the Aroostook or Big Presque Isle rivers.

Trout.—The brook trout (*Salvelinus fontinalis*) is generally distributed throughout the St. John River system wherever suitable conditions exist, and is the species

chiefly sought by sportsmen. It has been greatly depleted by overfishing and the presence of dams and pollutions. Local interests on both sides of the boundary line, especially on the upper river, appear to justify its joint protection as a source of profit in attracting visitors to the region. The great grey trout, togue or touladi (*Crystivomer namaycush*), which inhabits the upper part of this system, is also regarded as a sport fish, but the only boundary waters in which we learned of its occurrence are the lakes of the St. Francis River.

OBSTRUCTIONS AND POLLUTIONS.

Main river.—The only absolute barrier to the ascent of salmon in the St. John River is found at Grand Falls, where the conditions are entirely unsuited to the building of a fishway. The distribution of this species, therefore, must always be restricted to the lower river and its tributaries, but below the falls there are no serious obstacles to impede its movements in the main stream. Log driving and the drifting of saw-mill refuse with the current are both conspicuous and objectionable features of the region, which are supposed to exert a more or less harmful influence on the fish, but precisely to what extent it is impossible to say. The former practice could not be restrained but the latter might readily be stopped. The saw-dust is said to aid in the formation of shoals at certain places, whereby navigation is impeded, while the cedar drifts keeps the water charged with suspended rubbish, which settles quickly upon the banks and over the broad intervals at the close of every spring freshet.

Tributaries.—None of the tributary streams which the salmon used to frequent for spawning purposes have escaped at least some injury through the building of closed dams or the polluting influence of saw-mills; generally through both of those agencies combined. Even the Tobique River, the cleanest of the salmon waters in this valley, is disfigured in its lower part, while the Nashwaak River, terminating at Fredericton, N.B., is completely choked with saw-mill waste for several miles above its mouth and is barred by several dams, none of which provide a passageway for fish. Similar conditions prevail on practically all of the remaining provincial tributaries to which the salmon might resort, the lumber interests dominating every stream regardless of the rights or welfare of the public. The three tributaries which cross the boundary lines have also suffered very greatly in this respect, as explained below.

Meduxnick River.—This river has been continuously obstructed by a dam at its mouth, in the town of Woodstock, since about 1826. A fishway is said to have been added for the first time in 1863, but nothing could be learned of its history, and in 1893 no trace of it remained. The dam is relatively low and during high water a few salmon manage to pass over it. Two saw-mills are located just below the dam, and one a short distance above it, nearly all the waste from the former being allowed to enter the water, but at the latter it is now mostly disposed of on shore. The appearance of the Meduxnick at this place is extremely unsightly, due mainly to the accumulation of milling refuse, drift material, bark.

There are no other dams or saw-mills than the above on the main Meduxnick River. The north branch has a fall near its mouth, in New Brunswick, sufficiently high, it is stated, to bar the ascent of salmon. The south branch is free from natural obstructions, but contains at least six dams on the main stream the lower one being at Houlton, Me., and a few on its branches. None of these dams are provided with fishways, although supplied with gates for log driving, but there is no assurance that the latter would be kept open during the salmon run. The main stream has also five or six saw-mills and several factories for the making of starch from potatoes. As none of the former are above moderate size, they produce only a relatively small amount of waste, but as the volume of water becomes very small in summer the channel may readily be filled by this means. This we found to be the case in one or two places. Practically all of the refuse was formerly thrown into

the water, but scarcely more than the saw-dust is now disposed of in this way. The pumice from the starch works seems to be rapidly dissipated, and no evidence was obtained to show that it had a pernicious effect on fish life; in fact, it is locally believed to serve as food for some fishes. We heard of only one tannery on the Meduxnick River, and only a few small saw mills are reported on its tributary streams. It is not considered that the drainage of Houlton and Woodstock, the two largest towns on the river, is sufficiently extensive to be taken into account.

Big Presque Isle River.—This river was not visited, but from information derived from several sources we are led to conclude that its condition as a salmon stream has been greatly impaired by dams and milling refuse. Saw-mills are located at Tracey's Mills, N.B., and in the townships of Bridgewater, Blaine, Mars Hill and Easton, Me.

Aroostook River.—The lumber interests on this river are very great, and it contains some of the largest saw-mills in the St. John valley, the extent of its pollution from that source being in due proportion thereto. Examinations were made at Fort Fairfield, Caribou and Presque Isle, Me., and at several intermediate points, at all of which the conditions were found to be deplorable, the river being encumbered in many places with extensive banks of saw-dust, edgings, bark and shingle rubbish, sometimes reaching several feet above the surface. While only the sides of the channel may be thus filled in in the lower part of the river, higher up and in some of the former salmon tributaries, as in Caribou stream, for example, the channel is almost completely blocked from bank to bank. Much of this material is carried away by the spring freshets and distributed through the main St. John River, making room for new deposits the following seasons. Except for the small amount consumed by the steam mills, the river is made the common dumping ground for all the waste of this character, as the most convenient way of disposing of it, no regard being had for the public interests which are thus impaired.

The lower mill is in New Brunswick, near the mouth of the river; the remainder are all in Maine, three shingle factories at Fort Fairfield being especially conspicuous. The only dam across the Aroostook River was built in 1888, about three-eighths of a mile above the bridge at Caribou. It supplies that village with water and furnishes power for an electric lighting plant. The height of the dam above the water level below is about 14 feet in the summer, becoming much less in the spring. Salmon have been seen to jump it, but it is doubtful if many succeed in such attempts. Between 1889 and 1893, a temporary ladder, wholly unsuited to the purpose, was maintained at irregular intervals on the surface of the apron. In the latter year an appropriate fishway was constructed, and it is hoped that it may operate to remove the chief objection to the presence of the dam.

With respect to the principal lower tributaries of the Aroostook River, the Little Madawaska River, midway between Fort Fairfield and Caribou has several mills and closed dams, no pains being taken at the former to secure the retention of the waste products. Caribou stream has at present two lumber and shingle mills and three closed dams within a mile of its mouth, all located in the town of the same name. This stream has been effectually dammed, it is claimed, for 50 years, and its channel is completely choked with rubbish. On the Presque Isle River in the town of that name, about one and three-quarter miles above its mouth, there is a closed dam dating back over 30 years, and an accumulation of saw-mill waste, filling in a large proportion of the channel. Other mills and dams are reported in the upper waters, but they were not visited and positive information respecting them was not obtained.

Cedar Drift.—One of the most objectionable features of saw-mill waste, especially prominent on the St. John River, is the refuse derived from shingle factories, all of which, except the saw-dust and bark, retains its buoyancy for a long period. If there is sufficient water in the channel when rejected, it floats off at once; otherwise it accumulates about the mills until freshet time, being then carried down stream in enormous quantities to the annoyance and detriment of the different interests along

the lower. There is a much greater proportion of waste in shingle making than in the sawing of ordinary lumber, and the amount of rubbish derived from that source can scarcely be appreciated by any one not personally acquainted with the circumstances. That it has a baneful effect upon the habits of the fishes in the river, both when stranded and when floating in large quantities, there can be no doubt. The shingle mills are situated chiefly above Fredericton, on the main river and many of its tributaries, both in Maine and in New Brunswick.

SALMON FISHING.

Commercial fishing for salmon is carried on quite extensively in the lower part of the St. John River and in the Bay of Fundy outside, weirs and gill nets, both set and drifting, being used for that purpose. The season begins about June 1 and closes August 15. The number of weirs has been limited to 24, the privileges pertaining thereto being controlled by the city of St. John. Drift nets are employed in the harbour of St. John, and thence along the outer coast to Point Lepreau and the Wolves. Prior to 1895 they were not licensed and their number was not restricted. Set nets are used to a limited extent, and some poaching with drift nets is also carried on, in the tidal part of the river which extends to a distance of about six miles above Fredericton. Testimony was presented to the effect that both the net and weir fishing is being prosecuted on a more extensive scale than is justified by the present supply of salmon, but, while this is probably the case, we have not been able to entirely substantiate the fact. A limited amount of sport fishing is conducted on some of the tributary streams, but the opportunities are nowhere recognized as even fair except on the Tobique River.

SUMMARY OF CONDITIONS.

Fisheries.—The fact is thoroughly well established that the stock of salmon entering the St. John River system has been greatly depleted, the quantity resorting to it annually being very much smaller now than it was originally. This species formerly ascended many of the tributary streams below Grand Falls for spawning purposes, conspicuous amongst these having been the Aroostook, Meduxnick and Big Presque Isle rivers, each of which belongs mostly in the state of Maine. It is also undoubtedly a fact that this depletion has been brought about mainly through the agency of the lumber interests, the closing by dams of the majority of the spawning waters and their pollution and encumbrance by milling refuse, although other minor causes must have operated to the same end. The resulting conditions have affected the welfare alike of both sport and commercial fishing, and the latter has probably been overdone.

There is every reason to suppose, however, that if the natural conditions were again restored and a judicious system of protective measures instituted the supply of salmon would be much increased and might thereafter be maintained upon a satisfactory basis. Artificial propagation would aid materially in accomplishing that result. While it could not be expected to establish a commercial fishery by this means in the upper salmon waters, we anticipate that the advantages for sport fishing would be so greatly improved as to constitute a source of much profit, both locally and to the state and province. We strongly advise that the necessary steps be taken to accomplish this result.

In case the three international rivers alone, the Aroostook, Meduxnick and Big Presque Isle, were opened up and cleaned of their rubbish, the salmon would probably enter them in greatly increased numbers, but we are firmly convinced that the greater the area of available spawning grounds, the greater will be the advantages to be gained by each stream, and we, therefore, urge that the entire river system be considered as a unit in respect to this matter.

A large part of the milling refuse which passes down the river is derived from its upper waters above Grand Falls, where the interests of the brook trout demand the same measures of relief that may be accorded to the salmon.

Any means taken to increase the stock of salmon in the St. John would also benefit the alewives as well as the other anadromous species, all of which are of commercial value.

Navigation.—Ocean commerce stops at the harbour of St. John, but river steamers ply as far as Fredericton and flat bottomed boats ascend to Woodstock during periods of high water. Steamers are also used on some of the larger of the lower tributaries, and small ones may be employed to a limited extent above Grand Falls. The Aroostook, Meduxnick and Big Presque Isle Rivers, however, offer few, if any, facilities in this respect. The presence, therefore, of dams and saw-mill waste has comparatively little bearing on the subject of navigation in this river system, although the cedar drift gives some annoyance and saw-dust is said to aid in the formation of bars and shoals. The principal source of trouble is the extensive rafting of logs, for which, however, no feasible remedy can be suggested.

RECOMMENDATIONS.

In order to restore and protect the fishery resources of international interest in the St. John River system, the following measures seem to be demanded:—

1. That all dams throughout the system be provided with suitable fishways, except those used exclusively for log driving and containing gates, and that the latter shall be kept open at all times when the driving of logs is not actually in progress, and just previous thereto for the collecting of water.
2. That the construction of all new dams be subject to governmental authority and conform to such requirements in each case as the circumstances may warrant.
3. That the practice of throwing saw-mill waste of any kind into the water be everywhere prohibited; and that all existing accumulations of such waste in streams where it may be detrimental to the movements or spawning requirements of useful fishes be removed. As the saw-mills situated in the city of St. John have been able, for many years, to dispose of their rubbish without recourse to the adjacent river, it is not considered that this provision would work undue hardship in other places.
4. That it be prohibited to throw or to allow to pass into the water any garbage, lime, waste from gas works, or other deleterious substances from manufacturing or other establishments.
5. That commercial fishing be limited to tidal waters, and be so restricted therein as to insure an ample run of salmon and other anadromous fishes to their respective spawning grounds.
6. That uniform regulations be adopted for the protection of the salmon, trout and other useful fishes throughout the fresh waters of the system.
7. In case the measures above suggested are carried out, it is recommended that joint action be taken to increase the supply of salmon by artificial propagation.
8. It is recommended that all natural obstructions which impede the passage of salmon to important waters adapted to their spawning, such as the fall near the mouth of the Aroostook River, be examined with reference to improving the conditions for the distribution of that species.

ST. CROIX RIVER SYSTEM.

DESCRIPTION OF THE RIVER SYSTEM.

The southern half, approximately, of the boundary line between the state of Maine and the province of New Brunswick, above Passamaquoddy Bay is formed by the main St. Croix River and its eastern branch system, the latter including Monument Brook, at its source, and the Eastern Grand Lakes. The short west branch, draining the Western Grand Lakes, both of which lie wholly within the territory of Maine, joins the main stream about 20 miles above Calais. From Calais and St. Stephen down the St. Croix is a tidal river, with an average rise and

fall in the upper part of about 20 feet. Its shores are bold and picturesque. As far as Oak Bay, a distance of about 7 miles, the thread of the channel is narrow and tortuous, navigation being especially difficult above "The Ledge" (about $4\frac{1}{2}$ miles from Calais), where is located the customary anchorage for vessels of large tonnage. There is relatively deep water at and below The Ledge, while beginning at Oak Bay the river assumes more the characteristics of a fiord, deep water generally approaching close to both shores.

The upper limit of the tide is determined by a comparatively rapid rise in the river bed, commencing near the lower or main bridge connecting Calais with St. Stephen and continuing up stream through a constricted part of the river, a distance of about $1\frac{1}{2}$ miles, with an elevation of about 72 feet. These conditions have produced excellent water power, which has long been utilized for saw-mill purposes. Salmon Falls, about 14 feet high, is situated near the upper end of this ascent. Thence to Vanceboro, at the foot of the Eastern Grand Lakes, there is a succession of still waters, rips and rapids, with several low falls, the most important of which, called Sprague's Falls, $10\frac{1}{2}$ miles above the Calais-St. Stephen bridge, has a total height of 25 feet, distributed over a distance of 114 rods. The length of the river from Vanceboro to the Calais-St. Stephen bridge is $54\frac{1}{2}$ miles, its total descent in that distance being about 380 feet. This part of the river is not navigable. It receives a number of small tributary streams from both sides.

At Vanceboro' begin the Eastern Grand Lakes, consisting in succession of First Lake, Second or Spednic Lake, Mud Lake, Grand Lake and North Lake, with their connecting thoroughfares, the total length of the chain by channel route being about 42 miles. They are navigable in part, especially Grand Lake, by boats of moderate size. Small steamers or steam launches are now used upon them to a slight extent. Monument Stream empties into North Lake.

The west branch of the St. Croix River is similar in character to the east branch, and is about 9 miles long from its mouth to Princeton. The Western Grand Lakes, of which it is the outlet, cover a considerable area, the individual lakes composing it being, as a rule, more completely separated from one another than those of the eastern chain. The following waters, named in the order of their succession from the town of Princeton, are all that need be considered in this connection, namely, Lewey's Lake, Long Lake, Big Lake, Grand Lake Stream, and Grand Lake.

International Interests.—The international interests relate to (1) the protection of three species of anadromous fishes, the salmon (*Salmo salar*), shad (*Alosa sapidissima*), and alewife (*Pomolobus pseudoharengus*), (2) the protection of several game fishes in the upper waters of the system, (3) the regulation of certain minor fisheries on the Grand Lakes, and (4) navigation in the tidal part of the river.

Salt water fisheries.—The purely salt water fisheries in the lower part of the St. Croix River are considered separately, under the heading of Passamaquoddy Bay and vicinity.

IMPORTANT FISHES.

Salmon.—In the early times the St. Croix River was considered to be one of the most prolific salmon streams on the Atlantic Coast, and during a number of years it yielded a large annual catch, the fish being taken chiefly at and below Salmon Falls, in the upper part of Calais and St. Stephen, as they were making their way up the rapids. It was then the custom for re-idents of the neighbouring country to resort to this favoured spot at the proper season, for the purpose of obtaining supplies for their own use, and some market fishing was also engaged in. The fishery was carried on principally by means of dip nets, and while no records have been preserved to show the quantity actually caught in any year, statements recently secured from persons then living in the vicinity, furnish ample proof that the salmon ascended this river in extraordinary numbers. Daily catches of at least 100 barrels have been reported, and it is also stated that a single individual would occasionally obtain as many as 50 to 100, and even more, salmon in the same length

of time by the use of dip nets only. Large quantities were speared by the Indians' and gill nets and traps were early introduced for their capture in the tidal part of the river.

Until 1825 the salmon are said to have had a free passage-way to their spawning grounds, but in that year the first closed dam was built, at the head of tide, which remained unprovided with a fishway for many years. Although a few salmon were able to work over it at high water, it acted virtually as a check upon their movements, and in connection with pollutions and the extensive fishing then being carried on was the means of diminishing their numbers at a rapid rate. In 1850 it was estimated that the catch for the entire river did not exceed 200, and during the next 15 years the quantity taken annually remained very small, amounting in some seasons to only about 100. In 1866 and 1867 an increase was reported. Since then the catch has fluctuated from year to year, but no complete statistics of the same have been obtainable. The run is still so small, however, as to bear no comparison with its condition in the early part of the century. None of the lower dams has been without a fishway since 1869, however, and the failure of the stock to replenish more rapidly must be charged against the excessively polluted and encumbered condition of the river due mainly to the saw-mills.

The legitimate market fishery for salmon during recent years has been limited to a few trap nets located on the Maine side between The Lodge and Red Beach, and a few gill nets used chiefly in the upper part of tidal water at Calais and St. Stephen. Poaching is also carried on more or less extensively above the Calais-St. Stephen bridge by means of nets, and in the pools about the dams, by different methods. Very little fishing was ever done above Salmon Falls, nor do the fish seem to be sought for at present in any of the upper waters.

The St. Croix River receives a number of tributary streams which are said to be suited to the spawning habits of the salmon, and to some of these the fish are known to have resorted formerly. These streams all enter the main river above the Calais-St. Stephen set of dams, the lower two being the Magurrewock, on the Maine side, in the upper part of Calais, and the Moannes, on the New Brunswick side, opposite Baring, Me. The entire distribution of the spawning grounds of this species, however, has never been accurately determined. Salmon have been seen in the past as far up as Vanceboro' on the east branch, and in the upper part of Grand Lake Stream, on the west branch, but only a very few examples have been authoritatively identified from those places. To what extent they may have entered the lakes at the head of both branches is unknown, but it is probable that the bulk of the spawning was accomplished in lower tributaries.

Shad.—Shad were very plentiful in the St. Croix River before the construction of the lower or Union dam in 1825, and made their way over Salmon Falls in large numbers, being captured there in the same manner as the salmon. We have not been able to obtain any reliable information respecting their subsequent history, except that they rapidly disappeared, and for some years have been practically absent from the river, although a very few are observed occasionally. Their virtual extermination may readily be accounted for on the very plausible supposition that their original spawning grounds were located in that part of the main river above Salmon Falls, which is now more or less covered by the beds of saw-mill refuse and bark. The very foul condition of the water may also tend to hold them back, and their natural timidity, much greater than that of the salmon or alewives, may deter them from making use of the fishways through the dams.

Alewives.—The alewife is the third species of fish of anadromous habit which used to pass the tidal limit at Calais and St. Stephen, and find at least a part of its spawning grounds above Salmon Falls, at which place it was captured in immense quantities every season. Like the salmon and the shad, its ascent of the main river was impeded for a long period by the dam at Union Mills, but since the introduction of the fishway there it has renewed its upward movement, although in greatly diminished numbers. Its abundance is said to have fluctuated from time to time, but during the past few years a more marked increase has been reported from

several sources. Nothing definite could be learned respecting the present limit of its migrations up stream. Large quantities are seen every season both below and above Union Dam, and some have been noticed in places higher up the river, but if large schools now ascend beyond the upper dams at Milltown, that fact has escaped general observation. It is probable, however, that many do reach the still water above. The alewives have been less affected by the obstructions and pollutions than either the salmon or the shad, as they have had more or less uninterrupted access, for spawning purposes, to a number of tributary streams which enter the St. Croix River below Calais and St. Stephen. Their extermination in the St. Croix River system has thereby been prevented, and they have continued present in greater or less abundance. This species is not regarded with the same favour now as formerly in this region, and gives rise to only a limited fishery. Small quantities are taken in the few weirs above Red Beach, Maine, on Porter's Mill Stream, New Brunswick, and probably also in some other places.

Land-locked Salmon and Brook Trout.—Besides the sea salmon, the important game fishes found in the St. Croix River system are the land-locked salmon (*Salmo salar sebago*) and the brook trout (*Salvelinus fontinalis*). The "togue" or lake trout (*Cristivomer namaycush*) should probably also be included in this category. The land-locked salmon belong to both series of lakes forming the headwaters of the St. Croix River, but we did not learn of their presence in either the east or west branch except as they may possibly enter them for spawning purposes. Some of the lakes are much better suited to them than others, in which they may be scarce or practically lacking; and there are also certain streams which are better adapted to their spawning, the most noteworthy being Grand Lake stream of the western system. The land-locked salmon have everywhere decreased greatly in abundance, and at the present time they are said to be far less common in the eastern than in the western lakes. We were unable to obtain much information respecting them in the Eastern Grand Lakes beyond the commonly accepted fact that they were at one time very abundant there and quite generally distributed. Two of their principal spawning streams have been the one connecting Grand Lake with Mud Lake, and that draining the latter lake, both of which are now obstructed by dams at or near their entrances, the former being also seriously affected by tannery refuse below Forest City. These agencies alone would have been sufficient to cause the present depletion in both the lakes mentioned, and it is said that the dams and tannery at Vanceboro' have had a similar influence upon the fish in the lower lake.

Brook trout are reported to have been very plentiful at one time throughout the St. Croix River system in all of the many situations favourable to their existence. A marked decrease was reported by all of our informants, and, as this can be traced only in part to the pollution of the water, it has probably been caused chiefly by over-fishing and the extensive log-driving.

The "togue" occur in parts of both the Eastern and Western Grand Lakes, where they are fished for to some extent by trolling, but mainly by the use of lines through the ice in winter.

Market fishing in the Grand Lakes.—A very small amount of market fishing is carried on in the Eastern Grand Lakes by means of nets, the principal species said to be so taken being pike (*Lucius*), white perch, suckers and whitefish, which are shipped through Vanceboro' to different places in Maine and to Boston. While this method of fishing has been permitted in New Brunswick waters, it is prohibited on the Maine side, but the state law is said to be constantly evaded. The nets are employed mainly, if not entirely, in the lower shallow lakes, where excessive fishing by that method could not fail to have a serious result. The pike and white perch can readily be caught by means of hooks, a method followed to some extent in the Western Grand Lakes, especially through the ice in winter.

NAVIGATION.

On the St. Croix River system above Calais and St. Stephen the means of water communication are very limited, and have been utilized only to a slight extent. In

the upper part of tidal water, however, certain conditions prevail which affect navigation as well as the fisheries so seriously as to call for radical measures of relief in the interests of both. The conditions in question have been brought about by the practice, which still continues, of allowing the rubbish from the saw-mills near at hand to pass into the stream. The natural result has been to cause a general filling of the river bed from near the head of tide to the neighbourhood of The Ledge, a distance of about four and a half miles, thereby occasioning much inconvenience to the extensive shipping trade which centres at Calais and St. Stephen. As the exports from those two places consist chiefly of lumber, the product of the mills from which the refuse is derived, and the shipping and manufacturing interests are, therefore, practically identical, there is less local complaint with respect to this source of annoyance than would otherwise be the case. Many vessels, especially the larger ones and those not acquainted with the region, receive their cargoes at The Ledge, where there is good anchorage, while others proceed to the wharfs above, which they must approach at high water, as they become stranded on the soft bottom when the tide recedes. The Eastport-Calais steamer, drawing $5\frac{1}{2}$ feet at the time of our visit, makes use of two wharfs, an upper one near the bridge, which is the only convenient landing place for freight, and a second one nearly $1\frac{1}{2}$ miles further down. Between thirty and forty years ago, it is stated on good authority, a steamer of the same draught had no difficulty in making the upper wharf at all times except during extreme low spring tides. At present there is only about 3 feet of water abreast of that wharf at ordinary low tide, and for many years the lower wharf has been utilized for landing passengers when the tide serves badly. Some fifteen years ago it is reported that the depth of water in front of this wharf was about 12 feet; now the regular passenger steamer often grounds there even an hour or more before low tide, and it is not an unusual event for through passengers bound for Boston or St. John to lose their railroad connections in consequence.

The testimony of the older residents of Calais and St. Stephen, respecting the changes which have taken place during their experience, in the depth of water off and about the wharfs was found to be so conflicting that no satisfactory conclusions could be deduced from their several statements in that regard. Our inquiries, therefore, were extended to include a detailed hydrographic survey of this part of the river, in order to obtain data for comparison with the results of earlier government investigations in the same region, as described below.

OBSTRUCTIONS AND POLLUTIONS.

Natural obstructions.—None of the falls and rapids on the St. Croix River were sufficiently high and abrupt, in their natural condition, to prevent the ascent of the anadromous fishes. Salmon Falls did impede their passage to a certain extent, thereby causing them to congregate in considerable abundance in the pools below and on its slope and affording fishermen convenient opportunities to decimate their numbers, but they were able to surmount this swift water and to reach their spawning grounds above. Sprague's Falls and Grand Falls, higher up the river, are also said not to act as barriers, at least as regards the salmon, the only species that requires access to the upper streams.

Dams.—Beginning at the head of tide water is a series of four dams, designed to control the water power lying between the upper part of Calais, Maine, and Milltown and the upper part of St. Stephen, New Brunswick. These dams, named in the order of their succession from below, are designated as Union Dam, Cotton Mill Dam, Third Dam, and Fourth Dam. The first and the last two were constructed early in this century, Union Dam in 1825. Cotton Mill Dam was erected in 1881, and was built to conform to the irregular outline of Salmon Falls, which it almost completely covers. Until 1869 Union Dam remained without a fishway, and during that period it was, therefore, a serious obstruction to the ascent of all anadromous fishes, although salmon are said to have made their way over it to a limited extent at times of very high tide.

The Cotton Mill Dam has had a suitable fishway since the fall of 1881, but the latter is located alongside of the mill with its lower entrance just below the outlet of the drain through which the waste from the mill empties into the river. For convenience in driving logs past this dam, a chute has recently been excavated through the solid rock on the Maine side of the river. Although the water rushes through it at a rapid rate, its incline is not so great but that it may be used by the salmon, which are reported to have been seen ascending it, and the opinion generally prevails that it is better adapted to their wants than the ladder on the other side. Unfortunately, however, during times of drought it becomes necessary to place a temporary dam at the head of the chute, thereby entirely cutting off its flow of water.

The third and fourth dams consist essentially each of two wing dams, one extending offshore and up stream from each side of the river, and having an open channel between which entirely obviates the necessity for fishways. These passageways, however, are liable to be choked with logs and we found the upper one entirely impassable for fish from this cause at the time of our visit. Log booms could readily be arranged to prevent this occurrence.

A fifth dam is located at Baring, Maine, $5\frac{1}{2}$ miles above the Calais-St. Stephen Bridge, and although it extends practically across the river, much water is said to escape around the Baring end at some seasons. There is also fishway of suitable pattern near the centre of the dam, but it is reported to be generally out of repair.

No other dams are encountered until near the head of each branch. At Vanceboro', on the east branch, there are two dams, one with a fishway at the tannery, and another about 500 yards further up stream. The latter, used in connection with log driving, has no fishway, but is provided with 5 gates, one or more of which are supposed to be open at all times except during a few weeks in the spring. Following up through the Eastern Grand Lakes there is a driving dam with 2 gates at the heads of Grand Lake stream where it leaves Mud Lake, and a similar dam with one gate, used also by a saw-mill and tannery, at Forest City. The gates in both of these dams were shut down at the time of our visit, and, judging from appearances, they had been closed for a long time. Above Forest City the only obstructions of this character are small driving dams in many of the streams flowing into the several lakes.

At Princeton, just below the head of west branch, there is a combination driving and power dam, with an elaborate fishway now in poor condition. The next dam is at the head of the Western Grand Lake stream, and is provided with log gates only. Many of the streams tributary to the Western Grand Lakes also have log driving dams the same as on the eastern system.

We find therefore, that, with one exception, all of the dams reaching entirely across stream on the main St. Croix River and its west branch are provided with fishways, for the most part of suitable design, although some improvements in that respect are advisable and insufficient steps have heretofore been taken to insure their proper maintenance.

The dams at Vanceboro' and Forest City, those at the head of both Grand Lake streams, and some of the driving dams in the tributaries of the lakes, having no fishways, may be closed entirely for any length of time at the option of their owners, and might, therefore, readily be made to interfere with the spawning movements of the land-locked salmon and trout, but to what extent this may have taken place it has been impossible to ascertain.

Saw-mill refuse.—Ever since the beginning of the milling industry on this river, at the commencement of the present century, it has been the custom for the different saw-mills to allow the waste produced in cutting lumber to fall into the water, as the most convenient means of disposing of it. The result of this practice, long continued, has been to bring about conditions in certain parts of the river which are detrimental to other interests. This has been especially the case in the vicinity of Calais and St. Stephen, where both the fisheries and navigation have been seriously affected. The principal saw-mills in this neighbourhood are located at

Union, Third, and Fourth dams, from about two-thirds of a mile to one and two-thirds miles above the Calais-St. Stephen Bridge. Other mills are situated at Baring, about three and one-half miles farther up the river.

The part of the river containing Union, Third, and Fourth dams is much constricted and descends rapidly, producing continuously swift water throughout nearly the entire distance. Consequently a large proportion of the saw-mill refuse entering the water in this district finds its way directly into the tidal part of the river where much of it falls to the bottom, the remainder being carried seaward and soon dissipated.

The saw-mill waste consists of saw-dust, edgings, slabs, and other pieces of wood, planer shavings, shingle saw-dust, bark, &c. Formerly all of such waste that could not be utilized was dumped into the river. In 1871 a law was passed by the state of Maine which prohibited this practice, but no attention seems to have been paid to it until about 1883. At that time the mill owners on both sides of the river united, in their own interest, to partly remedy the matter by withholding all kinds of waste except saw-dust, as the floating wood set adrift at one dam caused more or less annoyance to the mills on the next dam below. The reason assigned for not also retaining the saw-dust was that the mills were not suitably constructed to permit of so doing, the saws being placed so near the level of the water that no device could be interposed to catch and hold it. At present, therefore, it is intended that only the saw-dust shall enter the river from the mills, the coarser kinds of refuse being burned or otherwise disposed of on the land, although a relatively small quantity continues to escape.

Bark is one of the most obnoxious features in all rivers, where lumbering is carried on extensively, and in the past large quantities were undoubtedly thrown out from the mills in question. The principal source of this nuisance, however, is furnished by the floating logs before they reach the mills, and for this no remedy can be suggested. The bottom of the river in many places is said to be much encumbered by this class of rubbish.

The effect produced at Calais and St. Stephen by the throwing of saw-mill refuse into the river is manifested in two ways: first, by the formation of extensive beds of extraneous matter on the bottom; and, second, by what may be regarded as an actual pollution of the water. The beds of edgings, saw-dust, &c., occupy a considerable area between the several mill-dams wherever the conditions are such as to cause their retention, the rubbish being piled many feet deep in places, as between the Cotton Mill Dam and Fourth Dam. Through this mass the swift current cuts deep and narrow channels, on either side of which the soft material reaches nearly or quite to the surface of the water.

At the Calais-St. Stephen Bridge, in tidal water, the deposits begin again and continue to near The Ledge, their extent and depth varying in different places in accordance with the contour of the bottom and the winding of the channel. The original river bed has been very greatly altered by this means, to the serious detriment especially of navigation. The edgings, slabs and bark constitute the most objectionable features of the saw-mill waste in this respect, as they tend to mat together, and after becoming water-logged and massed upon the bottom they are exceedingly difficult to move. They also serve to collect and hold the saw-dust and silt, which fill the interspaces and help to solidify the banks. As the saw-dust retains its buoyancy for a longer time than the coarser materials, it is carried farthest down stream, where it largely predominates.

The deposition and consequently the accumulation of saw-mill refuse takes place mainly during the seasons of low water in the river. The freshets and moving ice tend to remove it, and naturally have the greatest effect upon the sawdust and other lighter materials. The fact that the beds of rubbish persist throughout the year, however, clearly indicates that in the long run the influence of the freshets has not been adequate to overcome the effects produced by the outpourings of so many mills. In consequence of the reform instituted about 1883, through the agency of the mill owners, whereby only the saw-dust is allowed to enter the water, it is claimed locally that the chief objection raised to the practice of so disposing of the

waste has been removed, and that the scouring action of the freshets each season is sufficient for the removal of all accumulations which took place during the year preceding. The results of a recent examination tend, in a measure, to substantiate this belief as regards the tidal part of the river.

That part of the river lying between The Ledge and the Calais-St. Stephen bridge was made the subject of a hydrographic survey in 1873, under the direction of General George Thom, of the Engineer Corps, United States Army, and again in 1887 by the United States Coast and Geodetic Survey. In order to determine the condition of the channel at the time of our inquiry, two investigations were conducted by the United States Fish Commission, in 1893 and 1894 respectively. The former was designed to disclose the thickness of the beds of saw-mill waste by probing, while the latter was carried on in accordance with the same plan as the surveys of the Engineer Corps and Coast Survey.

A comparison of the data furnished by these surveys affords the following results, the figures being for the width of the channel between low water mark on either side: In accordance with the survey of 1873 the volume of water within these limits was 4,914,192 cubic yards; by the observations of 1887 this volume was reduced to 3,824,907 cubic yards, showing a filling in during that period to the extent of 1,089,285 cubic yards. The Fish Commission survey of 1894, however, indicates a volume of 5,033,166 cubic yards of water, an increase since 1873 of 168,974 cubic yards, and since 1887 of 1,258,259 cubic yards. Owing to the more or less yielding character and constant shifting of the refuse beds it cannot be assumed that the increase or decrease in their extent has continued uniformly, but the figures given above are at least significant of changes which have taken place, and point to a marked improvement in the condition of the river channel since the coarser refuse has been withheld. Notwithstanding the general improvement thus demonstrated, however, the continued grounding of the passenger steamer on the saw-dust beds off the lower Calais wharf at very low water, and its inability to reach the upper landing at lower stages of the tide than formerly, show that the same benefits have not been felt in all locations.

The general tendency of the ebb tide current is to deposit the saw-dust along or near the shores, while, in dry weather at least, the flood tide lifts the upper layers of these beds and carries them up and out into the stream until, becoming again saturated, the material falls to the bottom throughout the deeper portions of the channel. The wide distribution of the saw-dust is, therefore, aided by the alternating effects of the ebb and flood tide.

After a thorough consideration of the facts briefly set forth above and in spite of the favourable showing by the survey of 1894, we have been forced to the conclusion that the continued disposition through the agency of the river of even the saw-dust alone is detrimental to the interests of both navigation and the fisheries. While the former suffers through the changes produced in the configuration of the bottom, we are not prepared to say whether the deposits of saw-dust in tidal waters actually interfere with the movements of the anadromous fishes or not. Their spawning grounds naturally lie above the influence of salt water, and their impulse is simply to pass through this portion of the river. By its polluting influence, however the saw-dust certainly affects their welfare adversely. On both tides the water is more or less heavily charged with the fine particles of suspended woody fibre, which, in accordance with the degree of their saturation, are scattered through the different levels from top to bottom. The appearance of the stream is sufficient to indicate its uninviting condition, even had the pernicious effect of this character of pollution not previously been studied and demonstrated by others.

The anadromous fishes which ascend the river as far as Calais and St. Stephen must, at least, pass the lower or Union Dam to reach their spawning grounds. Those of the salmon occur in tributary streams, the lowest of which enters above Fourth Dam. The places which have been resorted to by the alewives and shad for spawning purposes are not definitely known, but it is possible that formerly one or other of those species found the conditions suitable between the cotton mill and fourth dam, although this is merely conjecture. Taking the most favourable view of

the case, however, all of the species in question would have to work their way past the four dams, encountering the same character of impediments as in the upper tidal waters, but in a greatly aggravated form—much narrower channels and a larger amount of suspended material. A few salmon and alewives still make the passage, but the shad, a more timid species, has ceased to frequent these waters.

Nothing positive has been learned respecting the present condition of the salmon tributaries, but they will probably demand some attention in case steps are taken to increase the supply. The spawning grounds of the shad and, to some extent, those of the alewives must have been located in the main river, where they have been more or less covered and damaged by the saw-mill refuse and the bark from floating logs.

There is only one saw-mill on the river above Baring, located at the head of west branch, in the town of Princeton, where all the waste is thrown into the stream. There are no sources of pollution of this character on east branch below the lakes.

Cotton Mill.—The only other important source of pollution on this river system below Vanceboro' and Princeton seems to be the large cotton mill (St. Croix Cotton Mill) situated in Milltown, N.B., by the side of the second dam at Salmon Falls. The testimony relative to the effects produced by the drainage from this mill is conflicting, and we were unable to remain a sufficient length of time on the spot to make our examination either thorough or conclusive.

The liquid waste passes out through a single drain having its outlet at the base of the dam near the mill, about 100 feet above the pool from which the fishway makes its ascent, although it is nearly 100 feet farther, around the edge of a rocky ledge, to the actual entrance to the fishway.

The bulk of the coarser sediment is supposed to be stopped by a catch basin extending below the level of the drain, but the sewage which escapes undoubtedly contains the usual quantity of chemical matter, both in solution and in suspension, composing the waste in all manufactories of this character. Although a list of the different chemicals employed in connection with the dyeing and bleaching processes, together with a statement of the quantity of each expended during stated periods, was furnished us, we had no means of determining the amount, character or strength of the mixtures when discharged from the vats.

A supply of pure water is said to enter the drain continuously from the river above the dam, filling it to a depth of about 6 inches, and serving both to flush it and to dilute its impurities. Sewage from one source or another also passes into the drain at practically all times when the mill is in operation, but the amount is much greater sometimes than at others. Moreover, a large part of this sewage consists of the water used in washing the yarns after bleaching and dyeing, and contains only a relatively small amount of foreign matter.

The harm caused by the sewage from the mill under present arrangements relates not so much to the general pollution of the water, even in the vicinity of the mill, as to the effect produced in driving the fish away from the pool through which they gain access to the fishway. The discoloured water from this source can often be distinguished for a considerable distance below the outlet of the drain. When the river is high, especially in the spring, the volume of water discharged over the dam becomes so great that the influence of the sewage must be imperceptible, but during the months when the salmon are working up stream the water is comparatively low and may become very low in the latter part of the season. It was in this condition at the time of our visit, in the early part of August, 1893.

The sewage does not, directly at least, effect the entrance to the log chute on the opposite side of the river, but the passage of water through that channel may be cut off for a considerable period during each year, as explained above. The pool below the cotton mill, however, has been and still remains the natural collecting place for the salmon before attempting to ascend the fall now capped by the high dam, and it seems to us that no better position could be selected for the fishway than the one it now occupies.

In Great Britain, where the subject has been carefully studied, the practice of allowing the waste products from cotton mills to pass into streams containing important fisheries has been condemned as prejudicial to the latter.

Tanneries.—The first tanneries encountered, in ascending the St. Croix River, are located at the head of east branch and of west branch, in the towns of Vanceboro' and Princeton respectively. There is one such establishment at each of those places and also one at Forest City, above Vanceboro', and another on Grand Lake Stream, above Princeton.

The waste products derived from these tanneries are as follows: The salt liquid resulting from the first soaking of the skins in water; the lime liquor in which the skins are immersed in order to swell them and loosen the hair, the fleshings and hair resulting from the scraping of the skins; the waste tan liquor; the tan bark after leaching; and the water used in washing the skins after scraping and after their removal from the tan vats.

According to the report of the British Royal Commission of 1863, appointed to investigate the question of river pollution, "Outside the tanning community itself there can be but one opinion, which is, that the refuse matters from a tan-yard are disgusting in a high degree, and should on no account be allowed to pass into rivers."

It was formerly the custom at the several tanneries on the St. Croix River system to dispose practically of all refuse through the medium of the adjacent stream, as the most convenient means of effecting its removal. The result of this practice, as in the case of the saw-mills, was manifested in two ways, by the deposition of much sediment upon the bottom and by the actual pollution of the water. The former effect was produced by the dumping of the exhausted tan bark, enormous quantities of which were disposed of in this way, and it has been permanent. Carried down by the current it has found lodging places in the eddies and still waters, where, in some places, extensive banks have thus been formed. The fleshings have also stranded under the same conditions, and, retaining their foulness for long periods, have contributed materially, it is said, toward injuring many of the spawning beds of the land-locked salmon and brook trout. The other kinds of refuse, being in liquid-form, have only a transitory influence, the extent of which is to be measured by the frequency as well as the amount of their discharge.

Within a few years the more serious features of this practice have been remedied. The bark, fleshings, and hair are no longer allowed to pass into the water, although occasional infractions of the rule are reported. The bark is now utilized as fuel and the fleshings, to some extent, as fertilizer. It is also claimed that the discharge of tan liquor has mainly been stopped, being returned again to the leaches after each using. The sewage at present consists, therefore, principally of the liquor from the soaking vats, and the waters used in successive washings. The relatively small percentage of chemicals and of animal impurities contained in these liquids, taken in connection with the small number and isolated position of the tanneries, makes it improbable that this source of pollution is very important at the present time, but it is deemed advisable that all liquids discharged from these tanneries should be rendered entirely innocuous, if possible, by some system of filtration or precipitation.

The harm caused by the tanneries has been done mainly in the past, and is irremedial as regards the tan bark at least. The injury produced by this substance, as well as by the other kinds of tannery refuse has been especially severe in the Western Grand Lake stream and in the stream and lake below Forest City, where the abundance of the land-locked salmon more particularly has been affected by this means, although the brook trout has undoubtedly suffered much, if not equally, from the same cause.

Less is known respecting the former distribution and movements of these species in the vicinity of Vanceboro' and Princeton, but the testimony tends to show that one or both of them once frequented those localities within the area affected by tannery refuse, and while a few trout may still be taken there, the land-locked salmon has disappeared.

In case the sea salmon had spawning grounds in either of the lake systems, as seems probable to some extent, that species must also have felt the influence of this polluting agency.

SUMMARY OF CONDITIONS.

The results of our inquiries on the St. Croix River system may be summarized as follows:—

The salmon, shad, and alewives formerly ascended the St. Croix River in very large numbers and had important spawning grounds above the limits of tide water at Calais and St. Stephen. The abundance of each of those species, however, has decreased so greatly, beginning in the early part of the century, that of the salmon and alewives, only small annual runs have taken place for many years, while the shad has become virtually exterminated. The agencies chiefly concerned in causing this decrease have been the dams, the waste from saw-mills and other sources, and over fishing, the most of which have been remedied in part, but not nearly to the extent required for the replenishment or even for the rapid increase of the supply.

It seems probable that the original spawning grounds of the shad and alewives have been more or less permanently injured by deposits of bark and saw-mill refuse, and that the condition of the salmon streams has been impaired in many ways. The salmon is much the most important of these anadromous fishes and the one most deserving of attention, but whatever measures are taken in its interest will also benefit the others. While the alewives have comparatively little market value in this region, their importance as an article of food for several of the salt water species makes their preservation on a large scale exceedingly desirable.

The land-locked salmon and brook trout, important and at one time common game fishes, the former restricted to some of the lakes and connecting streams at the head of both branch rivers, the latter having a wide-spread distribution, have both greatly decreased. This is supposed to have been due to the combined influence of tannery and saw-mill waste, the smaller dams in the upper part of the system, and overfishing.

Net fishing for pike, white perch, suckers, and whitefish is carried on in some of the Eastern Grand Lakes, in which, owing to their small size and slight depth, the stock is said to have been much reduced and to be in danger of becoming practically exhausted. Hook and line fishing for the same species, exclusive of the whitefish, is followed on the lower of the Western Grand Lakes, and this method should also be adapted to the eastern chain.

The St. Croix River system presents exceptional advantages for the development of an important sport fishery, which, under judicious management, could not fail to secure much greater local benefits than any market fishery which these waters might be expected to support. We are, therefore, of the opinion that the entire river system, as regards its fishes, should be considered primarily from that standpoint. This would involve the limitation of salmon fishing and of fishing for all species in the fresh waters to hook and line methods, the enactment of other proper regulations, the improvement of the condition of the waters, and the increase of the more important species by artificial means.

We find that navigation in the upper part of tidal waters has been impeded during a long term of years through the deposition of refuse materials coming from the saw-mills, and while the conditions have been somewhat improved as a whole by the withholding of the coarser kinds of refuse since about 1883, adequate relief cannot be secured until the practice of allowing any waste of this character to pass into the water has been entirely stopped.

RECOMMENDATIONS.

In conformity with the statements and suggestions made above, the following remedial measures are recommended:—

1. That the disposal, through the medium of water, of all kinds of saw-mill refuse be prohibited throughout the entire river system. Saw-dust is the only kind

of such refuse now understood to be disposed of in this manner, and its retention on land can undoubtedly be provided for at comparatively slight expense, as has been done in other places.

2. That all extraneous material encumbering the channel of the river in tidal water between the Calais-St. Stephen Bridge and The Ledge, and resulting from the deposition of saw-mill refuse, be removed. This measure is requested in the interest especially of navigation, but there is no doubt that the fisheries would also be benefited thereby. We do not consider, however, that such a step would be justifiable while the practice of allowing said refuse to escape into the river still continues. It would also be of great advantage to the fisheries if the beds of saw-mill refuse occurring between Union Dam and Fourth Dam, above tidal waters, could be removed to the extent of providing, at least, a wider and more direct channel for the passage of salmon.

3. That the sewage from the St. Croix cotton mill be disposed of in such manner as to prevent any harmful influence upon the salmon in that vicinity during their ascent of the river.

4. That the tanneries be prohibited from using the streams adjacent to them for the disposal of tan bark, tan liquor, fleshings, hair or other refuse which may be deleterious to fishes. All liquids from the washings of the hides, containing any harmful ingredients, should be purified before being allowed to enter the stream.

5. That all fishways and passageways through the several dams be placed in good repair and be modified, where necessary, to insure their greater efficiency; and that, subsequently, they be maintained in proper condition, and their approaches kept clear of drift materials. The construction of all new dams should be subject to government authority, and should conform to such requirements in each case as the circumstance may warrant.

6. That in the case of all log-driving dams, provision be made to keep one or more of the gates open at all times when their use is not actually required in connection with the driving of logs.

7. That in those streams to which the salmon resort for spawning purposes all sources of pollution be restrained, and all obstructions and existing impurities be removed so far as possible.

8. That net fishing be prohibited throughout the fresh water of the system.

9. That the capture of salmon in the neighbourhood of their spawning grounds and in the approaches to fishways, or by any means except hook and line, be prohibited.

10. That appropriate and uniform regulations be established with respect to all classes of fishing in the fresh waters of the system, the same having reference to methods and extent of fishing, close seasons, &c.

11. That, in the event of the removal of all obstructions and polluting agencies, and the establishment and enforcement of suitable regulations, the increase of the supply of both salmon and land-locked salmon by artificial means, be attempted through the co-operation of the two governments.

PASSAMAQUODDY BAY AND VICINITY.

DESCRIPTION OF THE WATERS.

The boundary waters which it is necessary to consider in connection with Passamaquoddy Bay and vicinity are confined within an area extending from West Quoddy Head, in Maine, to Point Lepreau, in New Brunswick, and from Grand Manan to the vicinity of Robbinston, Maine. The shores are irregular and broken with numerous headlands and bays, while the waters are studded with islands, both large and small, offering many facilities for the prosecution of the characteristic fisheries of the region. The rise and fall of the tide varies from 15 to 26 feet, causing strong

currents of very complex distribution. These conditions are especially favourable for the method of fishing with brush weirs which has been found most efficient in catching the small herring with which the region teems. The district is distinguished as being the centre of the sardine canning industry. Upon the Maine shore there were in 1895, 36 canneries, employing 4,564 hands, which turned out a product of 682,040 cases, valued at \$1,644,379. On the Canadian side there is in this region but one sardine cannery.

FISHES AND FISHERIES.

The principal fishes of the Passamaquoddy region are as follows:—

Herring (*Clupea harengus*), hake (*Phycis tenuis* and *Phycis chuss*), pollock (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), cod (*Gadus callarias*), smelt (*Osmerus mordax*), and lobsters (*Homarus americanus*).

Herring.—The herring is by far the most important species, and the prosperity of the fishing communities depends almost entirely on its abundance. The line fisherman finds it the most readily procured and serviceable bait, and moreover, the abundance of the species which he seeks is largely regulated by its presence or absence. When, for any reason, the great schools of herring fail to appear, the cod, the haddock and especially the pollock are less plentiful, being largely dependent upon these schools for food. The lobsterman also has difficulty in prosecuting his calling when the herring are scarce.

The immense quantity of young herring now used in the production of sardines, in addition to the large ones smoked and pickled, has made the species of vastly greater commercial importance than all the others of the region. For two reasons then, its own importance for food, and its value as a bait in the prosecution of the line fishery for pollock, haddock and cod, the prosperity of the fishing communities of the region, and of others depending largely on them, is governed by the condition of the herring supply.

The herring here occurring is the same species which has long constituted an important item in the wealth of certain countries of Northern Europe. On the Atlantic coast of North America its southern limit appears to be in the vicinity of Block Island, although small bodies are occasionally seen further south, while to the north it is known to extend well up the Labrador coast.

Although other places may be more important for the catch of adults, Passamaquoddy Bay stands pre-eminent in respect to the abundance of young herring, such as are used in the production of sardines. Formerly these herring, from 6 to 10 inches long, were in demand for the manufacture of oil, but it was not until the perfection of the canning process in 1878 that their great value for canning was recognized. They remain in the vicinity of Passamaquoddy Bay throughout the year, but during the cooler and rougher months they do not approach the shore so closely as to be taken in the weirs in any considerable quantity.

Much apprehension has at various times existed among fishermen and dealers concerning the effect of the sardine industry upon the supply of herring, it being predicted that the continued capture of such enormous quantities of immature fish must exhaust the supply. Our observations lead us to believe that these apprehensions are not so far warranted. Taking into consideration the entire Passamaquoddy region before described, more herring were taken in 1894 and 1895 than ever before; this was especially the case with sardine herring, many more being caught than could be utilized by the canneries, notwithstanding the fact that the pack was unprecedented. In consequence of this, many of the weirs were rarely fished, although containing an abundance of herring. The young of other fishes, such as alewives, pollock, hake and mackerel are occasionally taken with the herring in the weirs but never in great quantities.

Those who were apprehensive of a failure held that the catch was kept up by an increase in the number of weirs, and not by the maintenance of an average catch per weir. An examination of the records shows this assumption to be totally

unwarranted. Since 1879, when the sardine industry began to assume considerable proportions, the total catch has increased in a greater proportion than the number of weirs. In 1879 and 1880 the average yield per weir was 80 hhd., irrespective of the use to which the herring was put; in 1893 the average was 148 hhd.; while in 1895 the average was no less than 171 hhd. per weir. Recent advices from Eastport and Lubec state that the young herring have this year appeared at those points in unprecedented abundance, and some of the canneries have obtained part of their supply by simply dipping their fish from the wharfs by means of dip nets. A careful consideration of this whole subject, carried on since 1893, indicates that with the present conditions there is no need for alarm concerning the supply of young herring.

The smoked herring trade is now of less importance than it was formerly, but it still gives employment to a number of persons. The centres of the smoking industry are at Lubec and Grand Manan, but smoke-houses are scattered at intervals along the entire shore of the Passamaquoddy district.

Herring are not now salted or pickled to any great extent in this region, the industry being much less extensive than formerly when large quantities were imported from the Magdalen Islands to Eastport to be cured, their transportation and handling giving employment to a number of vessels and men. No pickling herring are now brought from a distance, the supply being derived mainly from Grand Manan and the spawning grounds near Machias. When regular runs of the fine "Quoddy River" herring occurred they were used mainly for pickling, but for a number of years this run of fish has been practically absent.

Winter herring.—The fishery for winter herring began to attract attention about 1864 and soon assumed important proportions, reaching its maximum between 1880 and 1885, and ceasing entirely in 1889, owing to the non-appearance of the schools upon the coast. The winter herring were adult fish, which were shipped to market in a frozen condition, and were used either for food or for bait in the line fisheries.

It would seem that these schools of winter herring appeared first off Grand Manan, soon afterwards at Campobello, thence moving into St. Andrew's Bay; sometime the schools would divide, a portion only entering St. Andrew's Bay, and another portion passing on up the Bay of Fundy. Between 1877 and 1883, a change in the regular habits of these schools began to manifest itself. The date of their first appearance became gradually later until in 1889, the last year of their occurrence, they did not arrive at Campobello until about January 10. Coincident with this retrogression in the date of their arrival they manifested a tendency to remain further off shore, and the fishery, which was entirely by means of gill-nets, moved out into deep water also. Though the fish were latterly more difficult to take on account of their being further off shore, there was no great diminution in their numbers, and the theory that they were caught up is untenable. The only explanation of their absence since 1889 is that they now spend the winter months elsewhere. Their actions during the last decade of the fishery closely resembled those which are said to presage the unexplained periodical disappearance of herring from some portions of the coast of Europe. It is believed that in the case of the winter herring in this region we may have a periodicity not before recognized on account of the short time during which the fishery has been pursued.

The absence of the winter school of herring has apparently had no effect upon the numbers of young herring in the Passamaquoddy district.

Line fisheries.—In the Passamaquoddy region, exclusive of Grand Manan, it is estimated that there are about 1,200 men employed in the hook and line fisheries for hake, haddock, pollock and cod.

The hake fishery is conducted on the outer shore of Campobello and eastward. It is a trawl fishery solely, being at its height in July and August. The haddock fishery is next in importance. This species is caught both in the Bay of Fundy and in the inside waters of Passamaquoddy Bay. The fishery is by means of trawls; it begins about 15th May and continues sometimes until January. The pollock fishery appears to be characteristic of the vicinity of Eastport; it is a handline fishery and

is confined to the inshore grounds. The fish usually arrive about the middle of June and remain until 25th July, a second school coming about 15th August and lasting until the end of September. There is no distinct fishery for cod, this species being taken with the haddock. It appears to be most abundant in the spring.

Smelt.—The smelt fishery in the vicinity of Passamaquoddy Bay is very limited. At Pembroke and other places in Cobscook Bay, west of Eastport, some bag net fishing is done under the ice. The fishery is also followed at some places in New Brunswick, but the output of the entire region is inconsiderable.

Lobster.—Since the failure of the winter herring fishery in 1889 there has been a marked increase in the importance of the lobster fishery. For many years, prior to that time, lobsters had been shipped from this region, but the fishery was carried on only in the spring, and was confined to the shallow waters near the shores. With the failure of the winter herring fishery, many men, finding themselves without employment, turned their attention to the capture of lobsters. They soon found that traps could be fished profitably in deep water, and the fishery was pushed with a greatly increased vigour. Although the number of lobster pots, as given in the statistics for Charlotte County, N.B., shows practically no increase since 1890, there is no doubt that the traps are fished during a greater portion of the year. Formerly lobstermen did not go far from home to engage in this work, but now traps are set all along the coast, fishermen leaving their home waters as soon as a falling off is manifested there. As a result of this extending of the fishery, the catch was doubled between 1890 and 1894, while its value was almost trebled. The following table gives the catch and value for the New Brunswick coast between Grand Manan and Point Lepreau, for the five years ending with 1894:

Year.	Fresh. Tons.	Canned. Lbs.	Value.
1890.....	657	.....	\$39,420 00
1891.....	553	31,056	26,467 84
1892.....	748	1,440	30,131 60
1893.....	944	7,000	76,540 00
1894.....	1,324	3,000	99,720 00

The fishery has assumed an importance which merits attention, and an effort should be made to regulate its needlessly destructive features, as, wherever the lobster fishery has been extensively prosecuted, the invariable experience has been that in the course of time depletion, and often utter failure have followed. The continued capture of small individuals, which have not yet reached the age of sexual maturity, cannot do less than precipitate the end. Such lobsters are used only for canning or for shipment to markets where no size limits are enforced, and the price which the fishermen receive for them is insignificant and pitiful, when we consider the effect of their capture upon the fishery and the prices received for the mature lobster. If permitted a year's further growth many of these "shorts" would be given a value five or ten times that which the fisherman receives by their premature capture. Owing to the sedentary habits of the lobster, individuals returned to the water for further growth would not be likely to stray far from their place of liberation, and the fisherman of any locality where this practice was followed would themselves reap the benefit of their own forethought and prudence. Most of the fishermen are in favour of fixing the minimum size at 10½ inches, and a recent enactment in Maine compels the fishermen to return to the water all lobsters of less length. This has caused the closing of certain lobster canneries in that state, but has relieved one of the greatest drains upon the fishery. In Canada lobsters of a smaller size may be taken. As a consequence the only cannery at Eastport has been removed to the opposite Canadian shore where they can still continue to capture undersized and immature lobsters.

Methods of the fishery.—Herring are taken in weirs and with gill-nets. The weirs are built of brush and are generally situated in some small cove or on the side of some point where shelter is to be had and where the tide does not entirely dry out in the pot; they are roughly constructed by driving in upright stakes, about which the walls are built by introducing fine fir boughs. They are of no particular shape, being built to conform to the bottom where they are fished, the mouth of the weir faces the direction from which the herring are expected to run; the wings are, as a rule, short, and no attempt is made to lead and hold the fish by any system of hearts or tunnels such as is done in the ordinary pound net. The fish enter the weirs during high water, and having passed the wings go directly into the bowl or pot where they remain. A small seine is then used by the fishermen to capture the fish which are swimming about in the pot; when thus secured in the seine they are baled or dipped into the fishermen's boat. The line fishery is conducted with the same style of handline and trawl as is used all along the Atlantic Coast. Smelt are taken under the ice in the ordinary bag nets used for that purpose and with the hook and the line; they are not often caught in the weirs, as they do not strike in until that fishery is over. Seines are not used to any extent save for the purpose of gathering in the herring taken in the weirs.

RECOMMENDATIONS.

International fishery interests in Passamaquoddy Bay and its neighbourhood are concerned chiefly with the preservation of the herring, and as no decrease of that species has been proved, beyond the disappearance of the winter school, which cannot be attributed to over-fishing, it is not considered necessary to suggest any changes in the methods employed, and the only recommendations made are as follows:—

1. As the present regulation providing for a close season on the principal spawning grounds off Grand Manan has undoubtedly been a wise one, and may have, to some extent, aided in maintaining the supply of herring, it is recommended that it be continued, and that a similar close season be adopted for a part of the herring spawning grounds off Machias.
2. It is recommended that a regulation be adopted prohibiting the use of herring for the manufacture of oil or fertilizer.
3. It is recommended that the minimum size of lobster which may be taken be fixed at $10\frac{1}{2}$ inches, and that all lobsters caught, by whatsoever means, under that size be returned alive to the water.
4. It should be made unlawful to take berried lobsters at any time.
5. With a view of protecting the smelt, a close season, extending from March 15 to July 1, is recommended, during which close season it should be unlawful to take smelt in any manner except with hook and line.

LAKE MEMPHREMAGOG.

Description of the lake.—Lake Memphremagog extends north and south across the international boundary line, being located partly in the province of Quebec and partly in the state of Vermont. It is elongate in shape, quite narrow in most places, and about 30 miles in length, two-thirds of which is in Canadian territory. Its outlet is the St. Francis River, a tributary of the St. Lawrence River. The depth is said not to exceed 60 feet in the southern part of the lake, but in the central and northern parts much deeper water occurs, the maximum recorded being over 600 feet, in the neighbourhood of Rondeau. The eastern shore is generally abrupt, but the western is boarded by shallow water.

Fishes.—The principal fishes of the lake are small-mouthed black bass, lake trout, whitefish, yellow perch, pike, bullheads, suckers, smelt, ling and eels.

Value.

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Sport fishing.—Many anglers are attached to the region by the abundance of black bass (*Micronterus dolomieu*) and lake trout (*Cristivomer namaycush*); and the yellow perch (*Perca flavescens*) is also classed among the sport fishes. There are several resorts for sportsmen about the lake, the majority being on the Canadian side of the line.

Market fishing.—The lake trout and whitefish (*Coregonus labradoricus*) have given rise to a limited amount of net fishing, which in recent years, however, has been mainly abandoned. They are taken by means of seines in the shallow waters to which they resort for spawning in the latter part of October and in November, and also by gill nets in the same places, but to a greater extent in deeper water. Both species are said to be captured more or less in company on these grounds, which would seem to preclude the use of nets for the whitefish alone, unless it be for a very short period.

Trawl lines are set occasionally for the lake trout, and trolling for the same species is carried on during the spring, summer and fall—chiefly at the bottom in the summer, and at the surface in the spring and fall. The latter method of fishing is followed extensively by about fifteen persons who supply the local demand. The lake trout are also fished for through the ice in winter in depths of 25 to 100 feet by means of handlines, and are speared to a slight extent in the fall. This fishing is mainly limited to the area lying between the Mountain House and Lord's Island, in Canadian waters. The entire catch is said to be disposed of locally. Seining is now permitted only in the waters of Vermont.

Conclusions and Recommendations.—The interests of this lake can undoubtedly best be served by fostering the game fishes, and, in our opinion, this should be done to the extent of prohibiting all net fishing. The lake has become an angling resort of much importance, and as long as its attractions in that respect are properly maintained the local welfare will be benefited more materially through the influx of visitors than by the continuance of a commercial fishery dependent on so small a basis of supply as that furnished by these waters.

The use of spears, which are employed on the spawning grounds, is also to be regarded as detrimental and should be stopped.

It is further recommended that the black bass and lake trout be protected by close seasons, extending from 1st November to 15th June in the case of the former species, and from 1st September to 1st January in the case of the latter.

LAKE CHAMPLAIN.

Description of the Lake.—Lake Champlain is divided mainly between the states of Vermont and New York, but it extends a short distance into the province of Quebec. Its outlet, the Richelieu River, beginning just south of the international boundary line and flowing northward into the St. Lawrence River, lies almost entirely in Canada.

International Interests.—International interests are chiefly concerned with certain conditions and practices prevailing in the north-eastern arm of the lake, terminating in Missisquoi Bay, to which our inquiries were mainly restricted. We do not find that the Richelieu River, under existing circumstances, presents any questions for serious consideration in this respect.

Character and Extent of Fisheries.—From a fishery standpoint the principal interests of the lake are in the direction of sport fishing or angling, which now constitutes one of its chief attractions as well as an important source of local revenue. The opportunities for commercial fishing have always been very limited, and at the present time it has few, if any, fishermen who can be regarded as professional, those who engage in this business for profit being mostly farmers residing along the shores. Their operations have, at the most, been restricted to short seasons, and their yearly catch has been inconsiderable.

In New York and Vermont the prevailing sentiment is strongly in favour of reserving the lake for sport fishing purposes, or at least of prohibiting all apparatus, such as nets and set lines, ordinarily employed to obtain supplies for market. It is contended that under such complete restrictions the pleasure travel to the region would be increased by the superior inducements held out for angling, and that more material benefits could be secured thereby than by the continuance of market fishing on the small basis here afforded. On the Canadian shores of Missisquoi Bay, however, net fishing is still looked upon with favour, and hence results the only serious contention respecting fishery matters which the lake presents.

The use of nets and practically all market fishing have been abolished by New York. The same status existed with respect to the Vermont waters of Lake Champlain in 1892. The regulations of Canada permit the use of seines along the shores of its territory during the spring and fall, when two species of fish enter Missisquoi Bay for the purpose of spawning. These are the wall-eyed pike, in the spring, and the whitefish, or shad-waiter, in the fall. The authorities of Vermont sought to secure the repeal by Canada of these fishing privileges, which resulted in the matter being referred to this joint commission. In the meantime the legislature of Vermont passed a law empowering the state fish commissioners to issue seining licenses to its fishermen in the event of operations being continued in Canadian waters. Advantage was taken of this provision in 1893, but by mutual agreement all fishing was stopped during 1894 and the spring of 1895. Vermont then legalized fall seining, to begin with the fall of 1895, a step considered by the Canadian government as terminating the temporary arrangement, and leading to the renewal of both spring and fall seining on both sides of the line. The main features of the seine fishery are as follows:—

Spring fishery.—In the spring the wall-eyed pike (*Stizostedion vitreum*) enter Missisquoi Bay in large numbers from the south along the eastern or Hog Island (Vermont) side of the long entrance. After remaining therein for a short period they return to the lake along the western or Alburgh shore. This movement is connected with their spawning habit, and is regularly repeated from year to year. While the species is widely distributed throughout the lake and must have many breeding places, the north-eastern arm apparently contains its most extensive and important spawning grounds. These grounds are located both in the open waters of Missisquoi Bay and in the lower parts of its tributary streams, the principal one being the Missisquoi River, which the fish ascend as far as Swanton.

There is more or less variation in the times of beginning and ending of the spawning movement, dependent upon seasonal conditions. The wall-eyed pike are said to begin to work north in February, the main run past Hog Island taking place in March and the early part of April, and the inward movement terminating between the middle and last of April. The return run along the Alburgh shore begins about the first of May and is generally completed by about the middle of that month; the heaviest part continues during only about two weeks. The movement up the Missisquoi River occurs in April and is of short duration, but in some years relatively large catches are made there by hook and line.

There is conflict of testimony respecting the actual time of spawning, but it seems to begin mainly about or slightly before the middle of April and to continue a week or two into May. By the laws of both Canada and Vermont, the close season for the species now begins on April 15. The wall-eyed pike taken on the seining grounds are said to be almost exclusively of mature size, ranging in weight from about $1\frac{1}{2}$ pounds up.

The only net fishing in this part of the lake which has been legally followed in recent years is the use of drag seines. The employment of such nets in the spring has been permitted by Canada between March 1 and April 15. All spring netting in Vermont waters was prohibited from about 1876 to 1892, when the contingent regulation before referred to was enacted, making an open season for seines, under certain conditions, between March 20 and April 15, but limiting their use to the waters north of a line connecting Stevenson's Point with Long Point. They were

so employed during the spring of 1893, were prohibited during 1894 and 1895 by arrangement with Canada, and were again permitted during the spring of 1896, when Canada once more licensed her fisherman, on the assumption that the passage of the Vermont law, granting unrestricted seining in the fall, virtually cancelled the agreement previously reached between the state and the Dominion. The number of seine licenses granted by Vermont in the spring of 1893, was 22, and in the spring of 1896, 32, every applicant who could show ownership or had a written lease to a regular seining ground within the limits prescribed, being recognized. In the Canadian waters of Missisquoi Bay, the number of seines employed has been from 10 to 15. The main part of the spring seining is done before the ice breaks up. It begins on the Hog Island shore, is taken up, subsequently, in Missisquoi Bay, and ends finally on the Alburgh shore. In former times when net fishing was unrestricted the use of seines was continued more or less during June, but as the fish did not collect together so abundantly as earlier in the season, smaller catches were made at that period, and the summer heat was detrimental to their preservation.

The wall-eyed pike are the principal object of the spring seining and the main feature of the catch at that season. The other species taken with it are perch, suckers, mullet, pike and sheepshead, the perch coming next in abundance after the wall-eyed pike. Very few black bass are captured in this connection. The total amount of the spring catch is relatively very small.

No satisfactory evidence has been obtained respecting the abundance of the wall-eyed pike at the present time as compared with the past. The statistics of the Canadian catch are not indicative of a decrease. The market fishermen on the Vermont shores are positive that no falling off has taken place, and the majority of the sport fishermen interviewed claim nothing more than a periodical fluctuation in abundance. Some of the latter, however, are confident that a general decrease has been manifested, although its extent has not been great.

Fall fishery.—The main object of the fall fishery has been the white fish or shad-waiter (*Coregonus labradoricus*), which, in its spawning movements, follows essentially the same course as the wall-eyed pike, entering Missisquoi Bay along the eastern shore and returning from it along the western shore. It has given rise, therefore, to essentially the same character of fishery, participated in by the same class of individuals. The run of the shad-waiter may begin as early as the latter part of September and continue through October and more or less of November. Its exact spawning time is not known, but it probably occurs mainly in November, although possibly commencing to some extent in October. Very few wall-eyed pike or black bass are captured in connection with it, the other part of the catch consisting essentially of the same species taken in the spring.

The common whitefish of the Great Lakes (*Coregonus clupeiformis*) is also supposed to be an inhabitant of Lake Champlain, the National Museum at Washington containing specimens received from that source some years ago, but *Coregonus labradoricus* is the only species which has been noticed in the seine catches recently examined. During most of the year the whitefish seems to resort to the deeper parts of the lake where no fishing is carried on and where it escapes observation. Practically nothing is known, therefore, regarding its distribution and habits except during the short breeding season when it comes into shallow water for the purpose of spawning. So far as we could learn, its spawning grounds are located mainly, if not exclusively, in the north-eastern arm of the lake. The fish are said to appear first in the shallow water between Butler's Island and Maquam, and to proceed thence through the passage by Hog Island into Missisquoi Bay, which they reach a week or two subsequently to their first arrival on the shore. So far as we could learn they never enter the Richelieu River.

No decrease has been observed in the abundance of this species. It is stated to range in size from about three-quarters of a pound to seven or eight pounds, but the majority taken in the seines are between one and a half and two and a half pounds in weight. The bulk of the catch is shipped fresh to New York, but some are salted for local use.

The fall seining was intermitted in the waters of both Canada and Vermont during 1893 and 1894, as before explained, but in the latter year the Vermont legislature passed a law legalizing this fishery, which was, therefore, engaged in during the fall of 1895. The number of licenses issued by Vermont was 85.

Statistics of the seine fishery.—The amount of the Canadian catch is reported officially at the close of each year, but a discrimination is not made between the quantities taken in the spring and fall. The figures for the past ten years are given in the following table. The wall-eyed pike belong almost entirely to the spring catch, and the whitefish exclusively to the fall catch, but it is impossible to say what proportion of the miscellaneous kinds was obtained in each season. The number of seines employed varied from ten to fifteen.

STATISTICS of the Seine catch in the Canadian Waters of Missisquoi Bay from 1884 to 1893.

Year.	Wall-eyed Pike.	Whitefish	Miscellaneous kinds.	Value.
	Lbs.	Lbs.	Lbs.	\$
1884.....	30,960	6,700	38,200	3,890
1885.....	17,000	5,400	36,000	2,620
1886.....	2,125	7,218	19,000	983
1887.....	22,800	11,400	34,200	3,078
1888.....	33,200	16,000	27,000	3,978
1889.....	22,000	11,375	33,400	3,004
1890.....	39,600	21,815	41,800	4,938
1891.....	32,440	12,340	44,400	3,694
1892.....	23,000	9,750	33,400	2,741
1893.....	29,440	6,250	35,200	2,903

No statistics of the seine catch by the fishermen of Vermont are obtainable except incomplete ones for the fall of 1895 and spring of 1896. In the former season the total value of the catch of both whitefish and miscellaneous species was \$6,478; in the latter the quantity of wall-eyed pike taken was 100 barrels, and of cull fish about 488 barrels, valued at \$5,175.

Sport fishing.—The black bass is the most important of the game fishes, but not being sufficiently abundant to meet the demands of the anglers, the latter fish extensively for the wall-eyed pike, and also consider the yellow perch as coming within their legitimate province. They desire to have both the black bass and wall-eyed pike reserved exclusively for sport purposes, but do not claim protection necessary for the yellow perch. The conditions for sport fishing are much the best in the northern half of the lake. There are a number of well known resorts and fishing camps for sportsmen, and every effort is being made by New York and Vermont to increase this class of tourist travel.

The lake trout is said to have been plentiful at one time in Lake Champlain, but it has practically disappeared.

Market Fishing Methods.—Seine fishing is one of the oldest methods that has been employed on Lake Champlain, and it has been carried on legitimately down to a later date than any other kind of net fishing, as before explained. Seines have been used in all parts of the lake, generally for the wall-eyed pike, at the northern end for whitefish, and at the extreme south principally for bullheads. Fall seining for whitefish was permitted by Vermont without restriction during October and November until 1892, and was again legalized in 1894.

Pound nets, trap nets and fyke nets were formerly employed to a limited extent, but their use has been prohibited during a number of years past. Both traps and

fyke nets, however, are still sometimes set surreptitiously, although this practice is deprecated as much by the seiners as by the sport fishermen. The latter kind of apparatus could undoubtedly be employed in many places so as to take only coarse varieties of fish without detriment to the sporting interests. It is permitted by Canada in the Richelieu River, and at the time of our examination in 1894, about 125 such nets were in use between St. John's and the head of the river. The open season is limited to the period from October to April, and the catch consists chiefly of bullheads, sunfish and eels. A few wall-eyed pike may be taken occasionally, but black bass are captured very rarely if at all. We are of the opinion that this special fishery can have no effect upon the fishing interests of Lake Champlain. No other form of net is sanctioned on the Richelieu River above St. John's.

So far as we have been able to ascertain, gill nets have never been used on the lake except on a very small scale and in shallow water. They are not regarded as an effective means of securing supplies for market, and there seems to be no desire among the fishermen to have them legalized.

The use of trawl lines is prohibited by both New York and Vermont, and in the Canadian waters of Missisquoi Bay there is no inducement for their employment. Set lines may be fished in Vermont waters under certain restrictions, and the local markets are supplied to a limited extent by the ordinary method of hook and line fishing.

Summary of conditions.—Lake Champlain presents favourable conditions for a certain class of sport fishing, but only very limited inducements for the prosecution of a market fishery. In New York and Vermont, as previously explained, the popular sentiment is so strongly prejudiced in favour of promoting the interests of the former that all methods pertaining strictly to the latter have practically been abolished except fall seining in Vermont; but in Canadian waters it is still desired to continue the use of seines both spring and fall, as heretofore. Local interests will, undoubtedly, best be subserved by fostering the sport fishing, and making the market fishery entirely subordinate thereto.

The common game fishes here recognized are the black bass, wall-eyed pike and yellow perch. Protection is especially demanded for the first two, the last not being held in much esteem. Market fishing has been directed more particularly toward the capture of the wall-eyed pike and the whitefish. In connection with them, relatively, large quantities of perch are taken, and also several other species of no direct interest to sportsmen, except an occasional maskinonge. The wall-eyed pike are fished for during their spawning movement in the spring, and the whitefish during their corresponding movement in the fall.

The spring fishery, therefore, removes a certain quantity of one of the game fishes every year, and its harmfulness to the sporting interests would be measured by the extent of the catch or by its effect in reducing the supply. We did not learn, however, that any appreciable decrease had taken place in the abundance of this species. Only a very small number of black bass is obtained in the course of the spring seining, as the remain in the deeper waters until a later date. In the event of a continuance of the spring seining, those having jurisdiction in the matter should be given full authority to limit and define the grounds which may be fished, and to so restrict the number of nets employed as to insure ample protection to the wall-eyed pike.

The fall seining presents an entirely different phase from the spring seining. The whitefish is not a sport fish, nor can it be caught by means of hooks. Only small quantities of wall-eyed pike or black bass are taken in connection with it, and those species can be released alive if need be. The supply is not sufficient to maintain a fishery meriting special consideration, and the question of its preservation or depletion is not of much moment, unless the young man serve as food for the game species at some seasons, a subject on which we have no information. The sport fishermen and authorities of Vermont are not opposed to its capture by seines under regulations which will prevent abuse of the privilege so granted. The only grounds in shallow water which the whitefish are known to frequent are contained

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within a limited area in the north-east arm, and the period of their run along the shore is of short duration. It may be advisable, however, to afford them some protection during the actual time of spawning.

The seining benefits only a small number of men, who are not in any sense professional fishermen, but generally farmers who seek through this means to add something to their income. The catch by each person is very limited, and the entire abandonment of the fishery would work comparatively little hardship. So far, however, as the practice is not injurious to the larger interests of the lake there seems to be no valid reason why it should not be permitted, especially in view of the fact that the benefits derived therefrom are demanded by one of the countries which shares in its advantages.

In the case of both the wall-eyed pike and the whitefish, practically the only time when they are collected together in sufficient numbers to make seining profitable is while they are approaching and are on this spawning grounds. They become scattered soon thereafter and the whitefish appear to retire immediately to the deeper water.

The privilege of using other kinds of nets than seines in waters contiguous to the boundary line is not requested, nor is it deemed advisable to permit the employment of any such, unless it may be the small class of fyke nets, which, under proper restrictions, could undoubtedly be fished without detriment to the sporting interests, and possibly to their advantage through the removal of some of the coarse varieties having predaceous habits. The seines do not make as extensive catches as the pound nets and trap nets, and may, therefore, be regarded as the least destructive of these methods. They also present the advantage of being always in sight when employed, and it is consequently very difficult to fish them illegally. Sturgeon, eels, catfish and a few other species might also be taken in the deeper parts of the lake by means of set lines without prejudice to the game fishes.

Recommendations.—The following recommendations respecting Lake Champlain are in conformity with the suggestions made above, namely:—

1. That no net fishing other than by seines be permitted in waters adjacent to the boundary line or elsewhere in the lake where international interests would be affected thereby.

2. That the use of seines be permitted from February 1 to March 31, inclusive, for the capture of wall-eyed pike and other associated species, but under such limitations as to localities and number of nets employed as shall amply provide against the decrease of the species named. Should further inquiry establish the fact that this fishery is proving harmful to the wall-eyed pike by materially reducing the supply, its abolishment is recommended.

2. That the use of seines be permitted during the month of October for the capture of whitefish and other associated species, under suitable restrictions as to localities and number of nets employed.

4. That the length of any seine shall not exceed 40 rods; and that the mesh of the seine shall not measure less than $2\frac{1}{2}$ inches in the bunt and 3 inches in the wings.

5. That the capture of black bass be entirely prohibited from November 1 of each year to June 15 following; that angling methods only be allowed for this species and the catch by each angler be limited to 15 fish daily; and that all bass taken in nets, and all bass measuring less than 10 inches long taken by anglers be immediately returned alive to the water.

6. That the capture of wall-eyed pike by any means, be prohibited from April 1 to May 31, inclusive, of each year.

7. That joint regulations be also adopted with respect to any game or other fishes, not specifically mentioned, which may require protection.

RIVER ST. LAWRENCE BETWEEN THE STATE OF NEW YORK AND THE PROVINCE OF ONTARIO.

Description of the waters.—For a distance of about 90 miles from the foot of Lake Ontario, to where the line of 45° north latitude crosses the river, a little above Cornwall, the St. Lawrence forms the boundary between the state of New York and the province of Ontario. In the upper part of its course, within the above limits, the mainland shores are from 5 to 8 miles apart, the intervening waters being thickly studded with islands of varying extent. This portion of the river is sometimes called the Lake of the Thousand Islands. At the foot of the Thousand Islands the river narrows rapidly, the current, which in the upper half among the islands has been moderate, runs more swiftly, and a short distance below Ogdensburg navigation is interrupted by a series of rapids, which prevents the upward passage of vessels. The water varies greatly in depth, being as a rule deepest in the long, still stretches, and shallow where the current is rapid; the bottom is either covered with soft mud or is hard and rocky, shoals and reefs abounding everywhere.

International Interests.—But little commercial fishing is carried on within the limits under discussion; in fact, on the United States side, in the waters of the state of New York, this branch of fishing is entirely prohibited, while in Canada its amount has been small, only a few fyke nets being permitted. A few set-lines for sturgeon have been tacitly allowed from both shores, but the number has always been small and they have not been regularly fished. International interests are, therefore, confined entirely to the protection and development of sport fishing, the facilities for which are unusually great. The region of the Thousand Islands furnishes one of the most important summer resorts for the people of both countries, and there can be no doubt that the sporting interests are here of vastly more consequence than the amount of commercial fishing which could possibly be carried on. It is estimated that between four and five million dollars are here invested in hotels, summer residences, cottages, camping grounds and parks, all of which are frequented by tourists and sportsmen largely interested in the sport fishing. More money is spent every year by people who come for sport than the river could ever be made to yield by commercial fishing. Not only are hotel keepers, transportation companies, guides, oarsmen and boat and canoe builders benefitted by the presence of the immense number of people who regularly visit the region between June and September, but the farmers on both sides are furnished with a local market for almost everything they produce.

Fishes.—The principal fishes found in this part of the St. Lawrence are black bass, wall-eyed pike, maskinonge, grass pike, sturgeon, bullheads, channel cat, eels, ling, perch, sunfish, suckers, &c.

Of these, the only ones of value to sportsmen are the black bass, wall-eyed pike, maskinonge and grass pike. On set-lines sturgeon, eels, channel cat and ling are caught, while the principal catch of the fyke nets is bullheads, perch, sunfish, suckers and grass pike, and to some extent black bass and wall-eyed pike, especially if these nets are fished in April, May and June.

Character and extent of fishing.—As before stated commercial fishing is prohibited under the regulations of the state of New York, and though a small amount of set-line fishing for sturgeon has been allowed at Cape Vincent and off Ogdensburg, this fishery was not considered to interfere with the purely sporting interests. The sturgeon set-lines vary in length, the average being below 600 feet; the hooks are baited with chubs, perch or alewives, or even pieces of liver or beef, only dead bait being used. On the Canadian side a few similar set-lines, baited and fished in the same way, have been employed, while prior to the summer of 1895 a small amount of commercial fishing with fyke nets had been licensed. These nets were generally fished from October to May; they were set in the mouths of creeks, or in shallow marshy coves, either on the main and or on some of the larger islands. They

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usually took coarse fish, though, no doubt, when allowed to be kept in the water through April and May, bass and wall-eyed pike would also be caught. During the summer of 1895 an arrangement was entered into between Canada and the state of New York, under which commercial fishing has also been prohibited on the Canadian side of the river, between Kingston and Prescott. In sport fishing, the methods employed are those known as trolling with spoon or minnow, rod fishing with live bait, and surface fly fishing. The sportsman uses a boat which is either anchored over some favourite bottom, or kept gently under way.

Summary of conditions.—Although a certain amount of commercial fishing has heretofore been carried on in the waters of the Thousand Islands, and in the river below yet the condition of the purely sporting fishery is such as is not elsewhere surpassed, and it is doubtful whether better fishing for bass, wall-eyed pike, or that always rare and highly prized fish, the maskinonge, can be found anywhere else, especially for an almost unlimited number of rods. Owing to the great extent of the fishing grounds, the numerous channels, reaches, leads and coves among the islands, the opportunities for quiet fishing cannot elsewhere be equalled.

Recommendations.—As an arrangement, approved of by the sporting community, has already been entered into for the greater part of the waters under discussion, between Canada and the state of New York, and the necessary legislation provided for, we consider it unnecessary to suggest any other regulations than those already agreed to. We are, however, of the opinion that a small amount of commercial fishing made with fyke nets fished during the winter months in creeks or marshy places for such species as bullheads, perch, suckers, sunfish, &c., could do no harm. If such nets were allowed they should not be set before 1st November, and they should be removed from the water by 31st March. Fished during such a season, in suitable localities, there could be no risk of their taking bass, wall-eyed pike or maskinonge. A set-line fishery might also be allowed for such fish as sturgeon, eels, ling and channel cat, as the removal of some of these fishes would certainly be of benefit to the sporting interests.

Under the arrangement made between Canada and the state of New York it was enacted:

1. That no commercial fishing be permitted in the waters of the St. Lawrence between a line drawn from Cape Vincent, in the state of New York, to the city of Kingston, in the province of Ontario, and a second line from the town of Prescott, in Ontario, to the city of Ogdensburg, in New York.
2. That within the waters above included the close season for bass, maskinonge, wall-eyed pike and grass pike be from the 1st day of January to the 9th day of June, inclusive, in each year.
3. That the limit of the number of bass to be taken by each rod, per diem, be fixed at twelve (12) and that the number of rods to each boat be limited to two (2).
4. That all undersized and immature fish be returned alive to the water, and that no bass under ten (10) inches in length be taken.

While we do not consider that the close season as enacted above by any means fully covers the spawning season of the bass, which in the region of the Thousand Islands extends from the 15th of May to the 1st of July, at least, yet when taken in conjunction with a size limit, a limit to the number taken by each rod per diem, and a further limit of the number of rods per boat, it may be allowed that the protection is ample for the present.

5. We would recommend a continuance of the above arrangement, and would further suggest that it be extended so as to include the rest of the St. Lawrence from the lower limit above mentioned, between the cities of Ogdensburg and Prescott, to the point where the river ceases to be the boundary between the two countries, at the crossing of the line of 45° north latitude.

LAKE ONTARIO.

DESCRIPTION OF THE LAKE.

Lake Ontario, the smallest and most easterly of the great lakes, is bounded on the south and east by the state of New York, and on the west and north by the province of Ontario. It has a length of 185 miles, an average width of 40 miles, and a total area of 7,339 square miles, including the Bay of Quinté, with an area of 145 miles. The lake is free from islands or shoals over its entire extent, except at the north-eastern end near where it discharges into the St. Lawrence River. The water deepens more rapidly from the south than from the north shore, the greatest depth, 123 fathoms, occurring about 12 miles off the former in the eastern part of the lake, along the south shore the 10-fathom line lies only a little more than one mile off the land, and the 50-fathom line about 5 miles on an average; on the north shore the same curves are reached at about double those distances. The bottom over most of the lake consists of mud, clay and hard sand, with rocks in many places near the shores; but north of a line drawn from Stony Point, in New York, to South Bay, in Ontario, the water shallows, and among the islands in this section the bottom is rough and hard, and there are numerous reefs and shoals.

The south coast has only two or three small harbours, but between Oswego and Cape Vincent, at the eastern end, the shore is broken by a number of bays, affording ample shelter for vessels and boats, and from these most of the fishing is carried on. The Ontario shore is more broken, and toward the north east the long, narrow and deep inlet, known as the Bay of Quinté, extends inland almost parallel to the lake front for about 35 miles, being separated from it by the peninsula of Prince Edward county. Most of the fishing on the Canadian shore is carried on from the Bay of Quinté, and between Toronto and Niagara at the western end.

MARKET FISHES.

Eleven species of food fishes are enumerated in the statistics for the United States waters of Lake Ontario, the relative importance of which in each of the years, 1885, 1890 and 1893, as indicated by the size of the catch, is shown by the following table:—

	1885.	1890.	1893.
1	Catfish.....	Herring and long-jaws.....	Wall-eyed pike and grass pike.
2	Herring and long-jaws.....	Sturgeon.....	Herring and long-jaws.*
3	Sturgeon.....	Catfish.....	Perch.
4	Wall-eyed pike and grass pike.....	Wall-eyed pike and grass pike.....	Sturgeon.
5	Black bass.....	Perch.....	Catfish.
6	Whitefish.....	Black bass.....	Eels.
7	Eels.....	Suckers.....	Suckers.
8	Trout.....	Eels.....	Whitfish.
9	.....	Whitefish.....	Black bass.
10	.....	Trout.....	Trout.

*Herring 52,111 lbs., long-jaws 112,887 lbs.

In 1885 the suckers and perch were included with the miscellaneous fishes and that indefinite class stood at the head of the list. In 1890 and 1893 the two species mentioned were separately enumerated, and in those years the miscellaneous fish fell to near the bottom of the series.

The relative importance to Canadian fisheries of the principal species at four different periods beginning with 1880, is brought out by the following table in which the several forms are enumerated in the order of the quantity caught:—

	1880.	1885.	1890.	1895.
1	Whitefish	Herring	Herring	Herring.
2	Herring	Whitefish	Whitefish	Grass pike.
3	Trout	Trout	Grass pike	Wall-eyed pike.
4	Wall-eyed pike	Grass pike	Black bass	Black bass.
5	Grass pike	Black bass	Trout	Whitefish.
6	Black bass	Wall-eyed pike	Wall-eyed pike	Trout.
7	.....	Sturgeon	Sturgeon	Sturgeon.
8	.....	Eels	Eels	Eels.

WHITEFISH (*Coregonus clupeiformis*).

Status.—This species, once abundant in Lake Ontario, is now not at all common on the United States side. In 1893 the fisheries yielded 45,380 pounds valued at \$2,787 giving it ninth place in the amount and fourth in the value of the catch. In 1890 it was also ninth in the catch, and in 1885 sixth, but during the early period of the fishery it was first in importance.

On the Canadian side it was first in 1880, second in 1885 and 1890, and fifth in 1895, the catch in the latter year amounting to only 126,650 pounds.

Distribution and movements.—This species is taken on all parts of the United States shore, but is caught most abundantly in Jefferson, Monroe and Oswego Counties. On the Canadian side it appears to be most abundant in the Bay of Quinté, where it occurs only in the fall.

Whether there is any migration or movement of the fish from one side of the lake to the other is not known, although there is some evidence of such a movement around the ends of the lake. The whitefish come ashore in the spring and fall, but during the warm and cold seasons of the year they retire to the deeper water.

Most of the whitefish are caught in gill nets, which are fished in depths of 10 to 20 fathoms. In the spring and fall they are doubtless taken by this means in shoaler water, and at those seasons they are obtained in seines wherever used, although Chaumont and Three-mile Bays appear to embrace the principal seining grounds. Formerly they were caught in seines off the Genesee River in June, but there has been no fishery for them at that place in recent years.

Spawning.—The spawning season begins late in October and extends into December, the principal time being probably during the last 20 days of November. They spawn in different parts of the lake, wherever suitable conditions prevail.

Decrease.—The general opinion of all engaged in the fisheries on Lake Ontario is that the whitefish supply has suffered great depletion. This, according to the testimony of the fishermen, began early in the history of the fishery, some dating it back as far as 1860. On the United States side the catches in the several years for which we have statistics were as follows:—

1885.....	Lbs.
1890.....	90,711
1893.....	148,771
1895.....	46,767

The following table gives the catches on the Canadian side at intervals of five years since 1870:—

	Lbs.
1870.....	621,400
1875.....	660,400
1880.....	729,900
1885.....	364,100
1890.....	405 350
1895.....	126,650

Prior to 1870 the catch appears to have been somewhat larger. A consideration of the complete returns between 1868 and 1895 shows that there has been a number of periods of good fishing interspersed with periods of a decreased catch, but the general tendency has been downwards and the catch in 1895 was the smallest ever recorded. Taking the lake as a whole, there has been a vast decrease in the abundance of the whitefish during the time covered by the statistics, and the falling off had already manifested itself when the first inquiries were made.

LAKE HERRING OR CISCO. (*Argyrosomus artedi*.)

Status.—This is one of the most abundant fishes of the lake, but its exact status cannot be determined because the bloater whitefish or "long-jaw" has generally been associated with it in the statistical returns. In 1893, the only year in which it was separately enumerated in the United States catch, 52,111 pounds, valued at \$1,466, were obtained. On the Canadian side no distinction is made between the cisco and the long-jaw.

Distribution and movements.—The cisco is found in all parts of the lake, but occurs in shallow water or near shore only during the spawning time in the fall. During the rest of the year they remain in the deeper water. So far as we have been able to learn, there is no movement of the species up and down the lake.

The fishery for the cisco is carried on chiefly during the spawning season in November. The principal catch is made in gill nets, which are set in gangs of six to ten nets each, in depths of a few feet to 75 feet, but generally less than 40 feet. At the eastern end of the lake trap nets are set for this species in the fall, and seines are also used for them in the same locality and at the same season. During the spring a few are caught in the seines incidentally to the fishery for other species.

Spawning.—The spawning time is in November, chiefly during the last half of the month. The fishing usually begins in October but is most general about the 5th to the 10th of November by which time the fish are said to be ripe.

The spawning grounds are in relatively shallow water near shore and on the shoals. The bottom called "finger-rock" is said to be the kind usually selected by the fish. The grounds, so far as they are definitely known, are on the south side of Point Peninsula, about Grenadier and Stony Islands, and in Chaumont Bay, Three-mile Bay and Bay of Quinté, but principally at the western end of the lake.

Decrease.—There has been an important reduction in the abundance of this species and likewise a notable decrease in the average size of those taken in this lake. Owing to the fact that the statistics on the United States side until recently, and on the Canadian side invariably, include the bloater with the herring, it is not possible to consider the matter from a statistical standpoint.

LONG-JAW OR BLOATER. (*Argyrosomus prognathus*.)

Status.—This recently described species of whitefish is one of the most important food fishes of Lake Ontario. The catch in 1893 amounted to 112,887 pounds, valued at \$2,977, which places it third in importance of the catch of that year. This species is known to the fishermen under several different names of which "bloater" and "blot" are the ones most often heard at the eastern end of the

lakes, although "bloater whitefish" and "long-jaw" are occasionally used there. Bloaters of small size are not always distinguished by the fishermen from the cisco, and in the earlier statistical reports both species were confounded under the name of cisco or herring.

Distribution and movements.—The long-jaw seems pretty generally distributed throughout the lake. It is not known to come into shallow water, however, but seems to be confined to the greater depths. It is known to all the fishermen along the New York shore, but is taken by them only in depths of 200 to 400 feet. As most of the deep water is closer to the south shore than the north shore, this species is much more frequently obtained by the United States fishermen than by the Canadian. During the winter they are believed to retire to the deepest parts of the lake.

Size, weight, &c.—The maximum length is probably over 20 inches, the largest we have seen measuring $15\frac{1}{2}$ and $15\frac{3}{8}$ inches, but the average is considerably less than this. The larger ones observed weighed less than $1\frac{1}{2}$ pounds, but examples weighing as much as 5 and 6 pounds have been reported.

Spawning.—There is considerable difference of opinion among the fishermen as to the spawning habits of the species. Examples taken 17th May, 1892, contained immature roe, except one fish in which the eggs were fully ripe. They have been found in immature condition in April and more or less ripe from the middle of June into July.

Decrease.—From a statistical standpoint, nothing can be said respecting the changes in abundance of the species. The general opinion is that there has not been a decrease.

LAKE TROUT (*Cristivomer namaycush*).

Status.—The lake trout has occupied the lowest position, as regards size of catch, in the list of market fishes in United States waters during each year in which statistics have been taken, only 6,204 pounds have been obtained in 1893. On the Canadian side of the lake, they are more important, having ranked third in the catches of 1880 and 1885, fifth in 1890, and sixth in 1895, when 109,300 pounds were caught.

Distribution and movements.—The distribution of the trout along the shores of Lake Ontario is much less general than it was in the past, and they are now rarely taken in many places where they were formerly abundant. At the present time, so far as the fishery is concerned, they are practically confined to the eastern and north-eastern parts of the lake, most of the catch on the United States side being made in Jefferson County, while in Canada, almost the entire output is accredited to Prince Edward County, which lies between the Bay of Quinté and the lake. The fishery is carried on principally in the fall in the shoaler parts of the lake, but a few trout are also caught incidentally in the spring. There is no fishery in the greater depths except for "long-jaws," and the nets used for that species have not a sufficiently large mesh to take the trout in any numbers. At one time trout were caught during the summer in depths of 300 feet on set-lines, but at present this method is not followed.

Spawning.—This species spawns on rock bottom in shoal water in the fall, probably from September to December.

Decrease.—Since 1880 the decrease of the trout has been remarkable, as will be seen from an inspection of the following table, which shows the annual catches in United States waters during the years in which returns have been made:—

	Lbs.
1880.....	569,700
1885.....	20,510
1890.....	41,010
1893.....	6,204
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We are not convinced that the large decrease in the catch between 1880 and 1885 was due entirely to decrease in the abundance of the fish; although we have no definite information to that effect, it may have been caused in some degree by a change in the activity of the fishery, induced by a reduction in the trout supply. In Canadian waters the statistics show a more gradual decrease, which in our opinion measures more accurately the rate of decrease in the species. The catch there at intervals of five years beginning with 1870 is given in the following table:—

	Lbs.
1870	621,400
1875	660,400
1880	729,900
1885	364,100
1890	405,350
1895	126,650

WALL-EYED PIKE (*Stizostedion vitreum*).

Status.—This species is variously known in Lake Ontario as wall-eyed pike, yellow pike, blue pike, doré, &c. Many fishermen regard the blue pike or black pike as a species quite distinct from the yellow pike, a belief apparently not borne out by any structural differences.

On the United States shore the wall-eyed pike ranked first in importance in 1893 and fourth in 1885 and 1890, although in both of those years the catch was larger than in 1893, when it amounted to 216,745 pounds, valued at \$8,317. These figures, however, include the sauger and the grass pike but, after eliminating those species, it is probable that the value of the wall-eyed pike alone would exceed that of any other species.

On the Canadian shore, in 1895, it ranked third, with a catch of 245,750 pounds, nearly the largest ever made on that side of the lake. In 1890 and 1885 it stood sixth and in 1880 fourth by size of catch.

Distribution and movements.—The wall-eyed pike is distributed throughout Lake Ontario, but is apparently most abundant in those parts near the St. Lawrence River and Niagara River, and in the Bay of Quinté. In the vicinity of the Niagara River it appears that the so-called blue pike is the common form and the only one of which the statistics take cognizance, two-thirds of the United States catch of that variety being there recorded. At the eastern end of the lake, near the St. Lawrence River, practically all of the wall-eyed pike, ranked as such in the statistics of 1893, were caught, and in addition about one-fourth of the total catch of blue pike was obtained in the same region. Between Jefferson County on the east and Niagara County on the west few wall-eyed pike are caught. The great majority of the blue pike are taken in gill nets, while all noted as "wall eyes" were secured in pounds and traps.

The fish come into shoal water in the spring for the purpose of spawning and remain there until late in October, when they pass into the deeper parts of the lake. The most important grounds for the trap net fishery for wall-eyed pike on the United States shore are in Chaumont and Three-mile Bays and among the islands at the eastern end of the lake. Some fish are also caught there in gill nets, but this fishery is more important in Niagara County, where the "blue pike" abounds.

Spawning.—Very little accurate information could be obtained as to the spawning habits. From the best gained it appears that the fish come out into shoal water along the shore and about the islands early in the spring for spawning purposes. Extensive spawning grounds are said to exist in Chaumont and Three-mile Bays. The state hatchery at Clayton has been obtaining its wall-eyed pike eggs from there, but the supply has never been as great as desired. It is pretty certain that good spawning grounds occur around nearly all the islands at the east end of the

lake and in the head of the St. Lawrence River. There is no spawning beds in Black River Bay or in the lower part of Black River, probably on account of the pollution of the water from the mills above Watertown.

Considerable difference of opinion exists among the fishermen as to the time of spawning, but April, May and early June probably cover the entire period. Indeed it is doubtful if more than an occasional straggler spawns as late as the first of June. There is a belief among many fishermen that the so-called blue pike spawns later than the wall-eyed pike, and that those found spawning in June or even as late as July are all blue-pike. However this may be, it is pretty certain that the bulk of the species spawns in April.

Food.—The species seems almost entirely piscivorous. Of many examples examined, nearly all contained fishes of some kind or other and scarcely anything else. The species found oftenest in their stomachs was the alewife. Among others seen were various minnows, young yellow perch and young suckers. No young whitefish, trout or lake herring were seen in their stomachs.

Decrease.—In the opinion of the fishermen the so-called yellow pike has decreased, as a whole, in United States waters during the last few years, but they believe that the "blue pike" is increasing. Some of the fishermen, particularly those in Chaumont and Three-mile Bays, consider that only local decreases have occurred, that the species have actually decreased in those bays because they have been overfished, but that elsewhere in the lake, in the bays and along the shores, it is still abundant, as could be shown if commercial fishing were allowed. This opinion is not without reason, and it is more than probable that this species is still really more abundant in Lake Ontario than recent statistics indicate.

On the United States side the catch was much heavier in 1890 than in 1885 or 1893, but as this is also true of all other species it was doubtless due either to unusually good seasonal conditions, or to some relaxation in the legal restrictions or in their enforcement. On the Canadian side there has been a constant increase in the annual catch of this species, and in 1893, 1894 and 1895 it was heavier than ever before. The apparatus has, at most, increased less rapidly than the catch, and the opinion that the wall-eyed pike has not decreased in the lake at large appears well founded.

STURGEON (*Acipenser rubicundus*).

Status.—In 1893 the sturgeon held fourth place in the size and value of the catch in United States waters, the amount taken being 125,293 pounds, valued at \$4,987. In 1890 it ranked second and in 1885 third in the quantity caught. On the Canadian side none were recorded in 1880, but in 1885, 1890 and 1895 it stood seventh in the size of catch.

Distribution and movements.—The sturgeon occurs throughout Lake Ontario and the St. Lawrence River. On the United States side nearly 80 per cent of the catch in 1893 was made in and near the St. Lawrence River, and about half of the remainder near the Niagara River. The former region included Chaumont Bay, Three-mile Bay and the waters about Grenadier, Stony, Duck and Galloo Islands, as well as the surreptitious fishing in Henderson Bay and about the mouth of Black River. On the Canadian side the conditions are reversed, and the bulk of the catch is made at the western end of the lake, largely in and near the Niagara River. The sturgeon are caught on both sides of the lake by means of gill nets, pounds, seines and set-lines, but owing to the amount of illegal fishing it is impossible to secure even approximate information concerning the matter. The gill nets, however, are the most important.

Spawning.—Very little is definitely known regarding the spawning of the sturgeon in Lake Ontario. There is no unanimity of opinion among the fishermen either as to time or place. The bulk of the evidence, however, seems to indicate that the usual spawning time is in June.

Decrease.—The sturgeon appears to have decreased greatly since 1880, the following table showing the catch for several years since then in United States waters:—

	Lbs.
1880.....	545,283
1885.....	386,974
1890.....	490,000
1893.....	125,293

It is supposed that the increase noted in 1890 was due to the more active fishery resulting from the increased demand which grew up subsequent to 1885.

On the Canadian side of the lake the catch is smaller, but the statistics likewise show a great decrease, as exhibited in the following table of the annual catch:—

	Lbs.
1885.....	84,700
1890.....	41,600
1893.....	39,290

ALEWIFE.

The alewife is supposed not to be indigenous to Lake Ontario, and the manner of its introduction is not known, but it now seems to be quite firmly established there, and is exceedingly abundant. It has no market value, although it is used to some extent as bait and fertilizer, and is supposed to furnish a large part of the food supply of the lake trout, wall-eyed pike and other species. It is said to spawn along the shores and to some extent in the creeks during the spring. This species has attracted special attention on account of the remarkable mortality which actually affects the schools. Large quantities of the dead fish become stranded upon the shores to the great annoyance of the inhabitants, and the fishermen believe that the pollution of the water and fouling of the bottom by this cause has had much to do with the depletion of the whitefish.

FISHING METHODS.

Although fishing began in Lake Ontario with the earliest settlement of its shores, it has never been carried on with the same energy or with anything like the same amount of apparatus as in the other great lakes. The appliances now in use, or which have at some time been employed, are seines, pound nets, trap nets, fyke nets, gill nets of various meshes, set-lines and spears.

Seines.—We have evidence that as long ago as 1807 seines were used for the capture of whitefish. They did not come into general use, however, until about 60 years ago, and seem to have been fished only in the spring and fall. They were first employed in April, or as soon as the ice moved off the shore, when the catch would be mostly wall-eyed pike. As the spring advanced whitefish would be taken in increasing quantities up to about the end of May or beginning of June, when all fish seemed to move off shore and operations would end. The fishing was entirely abandoned during the summer months, as the whitefish, the only species particularly sought for in those days, could not then be taken with the seines. The early settlers were not regular fishermen, and no doubt their time was mostly taken up with their clearing and farming operations. There was no inducement to them to adopt any other methods of fishing or to follow the fish into deep water, as they were always confident of making a certain and easy fishery when the fish came inshore either in the spring or fall. The seines were once more brought into use about the end of September; during the early fall more trout would be caught, and as the season advanced into November all the catch would be whitefish and herring, but the latter had little or no commercial value in those days. The same seining methods and seasons were followed on both sides of the lake. As far as can be gathered, the principal seining grounds, on the United States side, were between Cape Vincent

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and the mouth of the Oswego River; while on the Canadian side most of the fishing was carried on along the shores of the Prince Edward County peninsula, and for some distance westward. Though most of the seining was done within the regions above defined, the same methods were followed wherever suitable beaches occurred and the fish were known to approach the shore. Seining grounds had always to be prepared beforehand by removing all obstacles and obstructions from the bottom, so as to allow the seine to be hauled smoothly.

This method of fishing was pretty generally practiced down to 1860, since which date there has been a gradual falling off. The present regulations of the state of New York, which allow no commercial fishing within a mile of the shore except in Chaumont Bay, have practically put an end to their use on that shore, while in Canada they are no longer licensed. They had, however, fallen into disuse before the enforcement of any regulations against them, as in most localities the fish were not found inshore in sufficient abundance to pay. Besides wall-eyed pike, whitefish, herring and trout, they also were the means of taking bass, sturgeon and all the coarser fishes.

Seines are usually made with a 2 to 3-inch mesh in the bunt, and a 4 to 5-inch mesh in the wings. They are about 20 feet deep at the centre, narrowing towards the ends, and are from 20 to 200 rods long. They are generally hauled with the aid of a windlass. It is claimed by some that black bass are not caught in the seines, and by others that many are so taken; much likely depends upon the season and locality at which they are fished.

All the evidence procured shows that in the best days of fishing by this method some enormous hauls were made, single seines being credited with from 5,000 to 7,000 barrels in a season. There are also reports of from 20,000 to 30,000 whitefish being taken at a single haul. Salmon were obtained in large numbers during the spring seining in April up to about 45 years ago. An occasional one is still caught.

Gill Nets.—These nets first came into use about 1847. The method gradually became more general, and about 1860, as the seine fishery began to fail and a purely fishing population developed, a regular gill net fishery grew up. Its maximum as regards the whitefish was reached between 1870 and 1880, since which time there has been a gradual and steady falling off in the amount of gill netting used for both trout and whitefish.

Three general grades of nets are in use; a strong coarse net of from 9 to 11-inch mesh for sturgeon, a medium sized mesh of $4\frac{1}{2}$ to 6 inches for whitefish and trout, and a small-meshed net of from $2\frac{1}{2}$ to 3 inches for herring and cisco. As the Canadian statistics do not discriminate between the various grades, it is impossible to show the exact quantities of each in use. The amount of herring gill netting has not decreased.

When gill nets were first used they were employed entirely for whitefish and trout. Originally 100 rods was considered a long gang, and the nets were lifted every morning. They were fished in from 50 to 100 feet of water. As the fish became scarce, from 300 to 400 rods were used, the nets were set in deeper water and were left out longer. Whitefish and trout gill nets are from 12 to 15 meshes deep, and are seldom or never set in more than 150 feet, as beyond that depth these fishes are rarely found, the bloater or long-jaw being taken in their stead. The practice is to fish in the shoaler water spring and fall, the whitefish and trout remaining in deeper water during July and August.

Herring gill nets were not introduced until some years after this method of fishing for whitefish and trout had become general. For herring they are usually set in from 30 to 100 feet. The nets are made deeper than in the larger meshed ones, as it is claimed by the fishermen that the herring swim higher. The season usually opens towards the end of September and continues through October and November, as the fish move gradually inshore to the spawning grounds. Trout gill nets are usually made of slightly coarser twine and with a larger mesh than those fished for whitefish, though many fishermen use the smaller meshed nets for both. In some localities wall-eyed pike and grass pike are taken in the whitefish nets, the

practice being to use old nets for this purpose, as they are apt to get torn and damaged in releasing the fish. Whenever small sized gill nets are fished over hard bottoms where bass are running in June or July, a good many of this species may be secured thereby. The bloater or long-jaw is taken throughout the season in from 200 to 600 feet of water in the smaller meshed gill nets such as are fished for white-fish in the shoaler water.

Sturgeon gill nets are fished at the extreme ends of the lake, principally at the eastern end in New York waters and at the western end in Ontario waters. From two to twelve nets, each from 10 to 30 rods long, compose an ordinary outfit. Four or five nets are usually set in a gang in an average depth of about 35 feet, the best grounds being generally near shore. The practice is to lift them daily.

Pound nets.—Pound net fishing has never been carried on as extensively in Lake Ontario as in any other of the great lakes. Generally speaking, the bottom is too hard for the easy driving of stakes in localities where these nets could profitably be fished. They are also, no doubt, rather costly for the class of fishermen who operate on the lake. At one time from 30 to 40 pounds are reported to have been fished in Chaumont Bay and vicinity, but at the time of our inquiries only one net of this class was being fished in the lake. When employed they were made somewhat smaller than those in general use elsewhere, and they were never set in deep water or in long strings. The catch consisted mainly of wall-eyed pike and whitefish during the spring, and of whitefish, trout and herring during the fall. A few sturgeon were caught, but it does not appear that these fish were ever taken as abundantly by the pounds in Lake Ontario as they have been elsewhere. Black bass also do not seem to have been taken extensively by this means. There is no general desire at present to have this method introduced again.

Trap nets.—These small submerged nets have taken the place of the pound to some extent. The fact that they are less costly and can be set on any bottom has led to their extended use; they require no stakes and can be set or removed bodily. They are chiefly fished for wall-eyed pike, but if placed in deep water will also take whitefish, herring and trout. They are not licensed on the Canadian side.

Fyke nets.—These nets are generally employed for bullheads and course fish in the eastern end of the lake about Wolf Island and in the Bay of Quinté. If fished in May and June on suitable bottoms they would catch wall-eyed pike and bass, sturgeon are rarely taken in them.

Pound nets, traps, seines and fyke nets have been fished to a much greater extent at the eastern end of the lake than elsewhere, as the conditions are there much the most favourable for their use.

Set-lines.—Set-lines are extensively used for sturgeon, and are also employed for channel cat, ling and eels. The sport fishes such as maskinonge, black bass and wall-eyed pike are not taken by this means, as only dead bait is used.

Spears.—Spears are not now employed, but at one time their use was quite common, especially for the capture of salmon, which frequented most of the rivers and streams discharging into the lake from either shore. There was no market fishery for them after they had entered the streams, but they were speared for domestic use and large quantities were killed in this way, chiefly at night with the aid of a jacklight. Many more were taken than were required for food, and there was great waste in consequence. The Indians, who were then numerous, also speared them for food and to a small extent for barter.

EXTENT AND CAUSES OF DECREASE.

Of the species which are mainly fished for by the commercial fishermen of Lake Ontario, whitefish and trout have greatly decreased; herring and sturgeon have fallen off to a considerable extent, but there is no perceptible failure in the wall-eyed pike, bloater and black bass. Only a few fishermen on the south shore of the

lake carry on a distant gill net fishery in deep water for the bloater or long-jaw, and wall-eye pike and bass are not taken extensively by the market fishermen.

Lake Ontario was undoubtedly the first of the great lakes in which a considerable commercial fishery was established, and as in the other lakes, the earlier fishery was made entirely for whitefish, the trout, herring, wall-eyed pike and sturgeon being taken only incidentally. As the whitefish began to fail, however, other branches of the fishery grew up. As the country opened up and the population increased, a purely fishing community was developed, especially in the neighbourhood of the best fishing grounds. At first all the fish not intended for immediate local consumption were salted. As the demand for fish at other seasons than the spring and fall, and also the facilities for handling and delivering them increased, gill net fishing came to be resorted to. This began about 1847, and the use of such nets rapidly increased, until by 1860 an extensive offshore fishery by regular fishermen was being carried on. Already a diminution in the quantity of whitefish and trout coming in shore in the spring and fall had been perceived, and the seine fishery was declining.

Pound nets were never fairly tried on the north shore, but at the eastern end of the lake, of Jefferson County, a good many were employed as early as 1860. They were introduced about 1850 by fishermen from the sea coast of Connecticut. Their use was at no time general with respect to the lake as a whole, and it was soon found that trap nets, which could be set without stakes, answered the same purpose and were more economical and convenient.

Fyke nets have been used since the earliest records, but have always been fished in the mouths of creeks and in shallow bays. The coarse fish taken in them have not decreased, and they have had nothing whatever to do with the almost practical extinction of the whitefish and trout.

Lake Ontario is the only one of the great lakes in which we find an alarming decrease in the trout. As this falling off has taken place conjointly with that of the whitefish and is apparently due to the same cause, it will best suit our purpose to treat of them together.

The conditions we have to deal with in Lake Ontario are similar to those met with in Lake Superior. The area in which whitefish and trout occur is small compared with the total area of the lake. Whitefish are not often found in more than 40 fathoms and they are generally fished for in less than 30. Trout range into slightly deeper water, but are generally fished for at about the extreme depth of the whitefish. In Lake Superior we found the extreme limit of the trout to be about 60 fathoms, beyond which practically nothing but siscowet were taken. In Lake Ontario, the bloater replaces the siscowet in the deep water fishery, which is prosecuted from the south shore out into depths of 200 to 600 feet. On the north shore there is no distinct fishery for this species, though a few are taken in nets set at the deep water limit of the trout. The total area of Lake Ontario, excluding the Bay of Quinté, is 7,194 square miles, while the area between the 50-fathom curve and the shore amounts to only 3,753 miles, the area beyond the 50-fathom curve being 3,442 square miles. Thus, we find that the actual area to which the trout, whitefish and herring are limited amounts to only about one-half the total area of the lake.

As the deepest water is in the southern half of the lake, and the 50-fathom curve follows the south shore at an average distance of only five to six miles, the area on which whitefish, herring and trout might be taken in United States waters is naturally very small. The testimony of those interviewed as well as the statistics indicate that no very extensive fishery was ever carried on along this shore, and that the whitefish and trout gave out early. On the northern side of the lake the average distance of the 50-fathom line from shore is twice as great, thereby affording a correspondingly larger fishing area. This accords with the fact that the fishery has been more extensive, and as the boats seldom go more than eight miles from land, they do not reach the depth at which the bloater is found.

At each end of the lake there is also a shallow table on which a considerable fishery has always been made, and on which the bulk of the fishing is being carried on to-day, the principal species taken being herring and wall-eyed pike.

With a knowledge of the above conditions and of the practices of the fishing when it was at its height, it is easy to account for the early and nearly complete collapse of the fishery for whitefish and trout, which were chiefly caught out by the seines at an early period. There does not seem to have been any regular migration of these fish lengthwise of lake. They occurred along a narrow border of the lake and simply moved to feeding grounds in the spring and to spawning grounds in the fall, wherever the shoal water was suitable. There they were most abundant, and on those areas we still find the remnant of them.

The following tables shows the condition of the fishery for whitefish and trout on the north shore of the lake in 1868, the first year for which we have any reliable statistics, as compared with 1895:—

	1868	1895
Whitefish.....	1,156,200	126,650
Trout.....	612,000	109,300

There was seasons between those dates when the fishing seems to have rallied but, on the whole, the tendency has been steadily downward. The evidence indicates that the fishery in United States waters began to decline long before the first statistics were taken. As a further proof of the present scarcity of whitefish and trout in Lake Ontario, if any were needed, it may be stated that the United States Fish Commission was unable, in the fall of 1896, to procure on either shore of the lake a supply of eggs for the hatchery at Cape Vincent, while the Canadian Department of Fisheries has for years procured its supplies for the hatcheries at New Castle and Ottawa from Lake Erie and Georgian Bay. Most of the fishermen interviewed about the Bay of Quinté, where the bulk of the whitefish and trout is now caught, were of opinion that the present supply was being kept up solely by artificial means.

While it is likely that the extensive spawning grounds of the whitefish in the head of the Bay of Quinté have been injured by the deposit of saw-dust and other refuse brought down from the mills located on the large streams which empty into the head of the bay, and that the same character of pollution may have contributed to a minor extent in damaging the spawning beds in the bays at the eastern end of the lake, there can be no doubt that the chief cause of the decrease of the whitefish and trout was the overfishing by seines in the early days of the fishery, and that this decrease had commenced before either gill nets or pounds were introduced. The extensive gill net fishing which was carried on from 1870 to 1880, most extensively during the same season as the fall seining and when the fish were converging on their spawning grounds, must also have aided in the work of destruction begun by the seines, and this was particularly the case in the Bay of Quinté. We are led to believe that the most extensive spawning grounds for whitefish in the lake are at the head of this bay. The bay is long and narrow and a large number of fish begin to run into it from the lake as early as September. At this time many who had been fishing in the lake, move into the bay, in the sheltered and confined waters of which immense fleets of gill nets are set directly in the path of the fish to their spawning grounds. This fishing continues to the end of October and is particularly destructive.

The pound nets cannot have materially contributed to the present scarcity of whitefish and trout. Trap nets have only been fished in the bays at the eastern end, for wall-eyed pike, herring and coarse fish, and their influence at most has been purely local. Whitefish, trout and herring are not taken in fyke nets.

A question deserving of serious consideration in this connection is whether the continued decrease of the whitefish, herring and trout is not being materially aided by the absence in practically all parts of the lake except Chaumont Bay of those

sedentary fisheries by pound nets, trap nets, fyke nets and seines, by means of which the supply of the coarser and predaceous fishes is kept down in the other lakes. The laws on both sides of the line are essentially prohibitory of all such fishing methods, which, in our opinion, could, under proper restrictions, be employed without detriment to the sporting interests, and at the same time probably to the great advantage of the more important market fishes.

Among the fishermen there seems to be a pretty general impression that much of the decrease of the whitefish has been due to the presence of the alewives which, dying in great numbers, sink to the bottom and foul the feeding grounds. That this was not a primary factor is shown by the fact that the decrease of both the whitefish and trout began long before the introduction of the alewives, and there is no reason to believe that it has an important influence at the present time.

The decrease of the sturgeon has been greatest on the New York shore. This is due to the fact that the methods of fishing there employed have been such as would naturally take the sturgeon more abundantly. On the Canadian shore the fishery has never been as extensively prosecuted. Prior to 1882 no record was kept of the quantity taken as they then had no market value and when captured in the seines were destroyed and thrown away. There was a sudden drop in the catch between 1882 and 1885, due no doubt to the circumstance that about 1883 the use of seines fell off greatly. Most of the sturgeon are fished for in the shoal water at the extreme ends of the lake, where they are taken with large meshed gill nets and set-lines.

The herring also show a considerable decrease. The fishery for this species, now carried on almost entirely with small-meshed gill nets, was not prosecuted to any great extent until that for the whitefish and trout had ceased to be profitable. When seines were extensively used large hauls of herring were made as they came inshore to spawn on practically the same grounds as the whitefish, and at about the same season. The catch was then salted. The gill net fishing for herring began to be extensive about 1884. It is most prominent at the western end of the lake and in the Bay of Quinté. On the Canadian shore the mesh used is from 2 to 2½ inches, the larger size being also that more commonly used by the New York fishermen. As herring are generally fished for in shallower waters than whitefish, considering the limited area over which they are taken, there can be no doubt the fishery has been overdone. It is chiefly prosecuted in the fall when the fish are on the way to their spawning grounds and during the time that they are actually upon them. On the Canadian shore the size of the mesh has been gradually reduced and many complaints are made that the herring now being marketed are much smaller than they used to be. When pounds were fished in the eastern end of the lake large catches of herring were made in them.

A very small amount of the Lake Ontario herring is marketed fresh, and there is not much demand for such small herring in this condition. Large quantities are slightly smoked for immediate use, the balance generally being salted.

There is no indication of a decrease of the wall-eyed pike. The catch during 1890 in United States waters was much greater than in either 1885 or 1893. This was due to the fact that a much greater amount of apparatus was employed in that year.

As no seines, pounds, traps, fykes or gill nets are allowed to be fished within a mile of the New York shore, except in Chaumont Bay, and as pounds, traps and seines are not fished on the Ontario coast, it follows that the wall-eyed pike are being pretty well protected. The bulk of the catch is made in gill nets and by sportsmen with hook and line.

The only distinct fishery for the bloater is in the deep water off the southern shore, where it is conducted on a very limited scale with gill nets. It should be capable of considerable development, as these fish are known to occur in great abundance in depths of 200 to 600 feet.

No regular commercial fishery is carried on for the black bass, and when taken in the nets of fishermen, it is by accident. The regulation which prohibits the use of any form of net along the greater part of the New York shore within one mile of the land, was adopted with the view of protecting this species. While doing this, it

also virtually prohibits the capture of the wall-eyed pike, grass pike, perch, suckers, bullheads, eels, and the remainder of the predaceous and coarser fishes. On the Canadian shore, all commercial fishing in the lake is done either with gill nets or set-lines, a few fyke nets being used in the shoal waters of the Bay of Quinté. Here, again, the bass are most thoroughly protected. The statistics, consequently, show no decrease in this species, while the testimony of all persons examined by us tends to prove that the bass were increasing. A register kept at one sporting resort showed that more bass were taken by the sports-men stopping at that particular hotel, than were caught by all the commercial fishermen in the lake.

RECOMMENDATIONS.

In view of the extent to which the supply of both whitefish and lake trout has become exhausted in Lake Ontario, any regulations looking to the protection and increase of those species, in order to be effective, should be decidedly stringent. With respect to the fisheries for them and for the other important fishes of the lake we recommend as follows:—

1. That a close season be adopted for both the whitefish and lake trout from the 15th day of October to the 31st day of December, between which dates they shall not be fished for or taken in any manner.

2. That in the Bay of Quinté the close season for whitefish extend from the 1st day of October to the 31st day of December, and that the use of herring gill nets in that bay be prohibited during November.

3. That the minimum size of mesh in the gill nets fished for whitefish and trout be fixed at 5 inches, in the herring gill nets at $2\frac{3}{4}$ inches, and in the sturgeon gill nets at 11 inches.

4. That the quantity of gill nets used in connection with each fishery be restricted within proper limitations.

5. That the use of baited set-lines for sturgeon be permitted, but that the capture of that species by means of naked hooks or grapplings be prohibited.

6. That all sturgeon measuring less than 4 feet long, taken by any means, be returned alive to the water.

7. That a close season be adopted for the black bass from May 1 to June 15; that all black bass measuring less than 10 inches long, by whatever means taken, be returned alive to the water; that the number of bass taken by each rod per diem be limited to twenty, and that the number of rods to each boat be limited to two.

8. That it be permitted to fish fyke nets and trap nets in the inshore waters of the lake, for the capture of the coarser fishes, between the 1st of October and the 30th of April, within proper limitations as to number and under such restrictions as shall prevent their being set on the spawning grounds of whitefish, trout or herring, or in such manner as to interfere with the spawning movement of those species.

9. That the mesh in the bag of all trap nets and fyke nets measure not less than $2\frac{1}{2}$ inches in extension when in use.

10. That the use of seines on or about the spawning grounds of any of the important fishes during their spawning season be prohibited.

11. That the joint efforts to increase the supply of whitefish and lake trout by artificial means be continued, and that the scope of that work be increased to the fullest extent possible. It is recommended that the planting of the fry be not restricted to one part of the lake, but be extended to as many of the important spawning areas as possible.

12. That the throwing into the water of fish offal, including dead fish taken from the nets, of city garbage and of all other substances deleterious to fish life be prohibited. That steps be taken to prevent injury by the waste from saw-mills, gas works, oil refineries, &c., especially in tributary streams containing spawning grounds of important fishes.

LAKE ERIE.

DESCRIPTION OF THE LAKE.

From a fishery standpoint Lake Erie is especially noteworthy because of its relative shallowness as compared with all the other large lakes of the chain, a feature which has determined its greater proportionate richness in aquatic products. The deepest water, reaching a maximum of 35 fathoms, occurs in the neighbourhood of Long Point, Ontario, and off the coast of Pennsylvania and of the western end of New York, the depths elsewhere not exceeding 14 fathoms. Westward of a line connecting Point Pelee with the entrance to Sandusky Bay, moreover, the maximum limit of depth is only seven fathoms, this shallow area or platform being characterized by numerous reefs and islands and containing the best defined spawning grounds of at least two of the more important species. Throughout the deeper parts of the lake the bottom consists chiefly of clay, with considerable areas of sand and mud; toward the margins, clay, sand, gravel and mud occur, with occasional rocky patches near the shore.

Owing to the shallow water, the seasonal changes of temperature have a more pronounced effect than on any other of the great lakes, ice forming to a greater extent in winter, and the summer heat being more severely felt. This diversity of physical conditions induces extensive periodical movements on the part of several species, which greatly influence the seasons and methods of the fisheries in different places and render difficult the harmonizing of the many interests concerned therewith.

The area of Lake Erie is about 10,000 square miles, making it next after Lake Ontario, the smallest of the great lakes. Its inferiority in that respect, however, is compensated for by the fact that it affords opportunities for fishing throughout its entire extent, and during some years the catch has been greater than the combined catch of all the other lakes of the system.

MARKET FISHES.

The statistical investigation of the fisheries in the United States waters of Lake Erie in 1893 took notice of fifteen varieties of market fishes which are recognized by the fishermen, but between which the latter do not always discriminate in making a record of their catch. Other kinds, taken in very small quantities, were considered collectively. In the table which follows the fifteen varieties separately accounted for are enumerated under three heads in a manner to illustrate their relative importance, based upon (1) the price per pound as paid to the fishermen, (2) the extent of the catch marketed, and (3) the value of the catch. The higher grades, with one exception, retained practically the same relations in the Canadian fisheries of 1893, but the coarser grades were not there separately enumerated.

FISHES CAUGHT in the United States waters of Lake Erie and Marketed in 1893—

Arranged by Price per Pound.		Arranged by Size of Catch.	Arranged by Value of Catch.
1	Black bass	Herring	Herring.
2	Whitefish	Blue pike	Blue pike.
3	Lake trout	Saugers	Whitefish.
4	Wall-eyed pike	Yellow perch	Saugers.
5	Pike	Sheepshead	Wall-eyed pike.
6	Sturgeon	Suckers	Yellow perch.
7	Catfish	Whitefish	Sturgeon.
8	Blue pike	Wall-eyed pike	Catfish.
9	German carp	Sturgeon	German carp.
10	White bass	Catfish	Suckers.
11	Saugers	German carp	Lake trout.
12	Yellow perch	Lake trout	Black bass.
13	Herring	White bass	Sheepshead.
14	Suckers	Black bass	Pike.
15	Sheepshead	Pike	White bass.

But few changes have occurred in the relative extent of the catch of the higher and preferred grades of fishes since 1885, when the first complete statistics of this subject were taken by the United States government. This fact is brought out by the following table, based entirely upon the figures for the United States.

1885.	1890.	1893.
Herring.....	Herring.....	Herring.....
Blue pike.....	Blue pike.....	Blue pike.....
Saugers.....	Saugers.....	Saugers.....
Sturgeon.....	Sturgeon.....	Sturgeon.....
Whitefish.....	Whitefish.....	Whitefish.....
Wall-eyed pike.....	Wall-eyed pike.....	Wall-eyed pike.....
Black bass.....	Black bass.....	Black bass.....
Lake trout.....	Lake trout.....	Lake trout.....

Marked changes, however, have taken place in the actual amount of the catch of several species, and some of the inferior grades have attained much greater prominence owing both to the decreased abundance of the better kinds and to the increased demands of trade.

The output of the Lake Erie fisheries has always been much greater in United States than in Canadian waters, as shown in the following table, which gives the total weight of the catch of fish for each of three years, the only years for which such a comparison is possible:

Year.	United States.	Canada.	Total.
	Lbs.	Lbs.	Lbs.
1885.....	51,456,000	7,605,000	59,061,000
1890.....	64,850,000	7,890,000	72,740,000
1893.....	42,968,000	9,410,000	52,378,000

The principal species from a commercial standpoint are the whitefish, herring, pike-perches, and sturgeon, of which the valuation of the catch in 1893 was about 85 per cent that of the entire lake catch. Of the remaining species the majority are either relatively scarce or inferior in quality, but the catfishes and yellow perch are conspicuous features of the fishery. Although regarded primarily as a sporting fish the black bass is also taken incidentally, in small quantities, for market.

WHITEFISH.

Status.—The whitefish ranks first in quality and market value among the commercial fishes of Lake Erie, and is, therefore, the one most highly regarded by the fishermen. It was the principal object of the early net fisheries of the lake, and for a considerable period composed the greater part of the output. It has, however, suffered great depletion, until in 1893, owing in part also to the development of the fisheries in other lines, the value of the catch amounted to only about 9 per cent of the total yield of all species.

Distribution and movements.—The principal habitat of the whitefish is the deeper waters in the eastern part of the lake, to which it seems to be mainly confined during the greater part of the year. Two regular movements, one occurring in the

spring the other in the fall, greatly increase the area of its distribution during limited periods. There is practically no fishery for this species in January, February and March, at which season it has never been brought under observation. The gill netters, mainly from Dunkirk and Erie, generally begin to set for whitefish between the first and middle of April, and continue their operations until the middle or latter part of December following. This deep water fishery has never been extended west of the region off Ashtabula, Ohio.

The gill net grounds extend mainly from about five miles off shore to the middle of the lake, the depth ranging from about 12 to 30 fathoms and the bottom consisting of clay and mud. There is a greater or less movement of the fish within these limits, of which the fishermen have cognizance and which seem to be influenced by changes in the season and weather. In the early spring the best fishing is said generally to be obtained eastward of Dunkirk in relatively shallow water, the body of fish working westward and into deeper water as the season advances, and again returning to the deeper water as the winter comes on. It is probable, however, that the early spring distribution in abundance is more wide spread than the above would indicate, judging from the extent of territory which the fishermen may then occupy. The extent of the gill net catch varies greatly with the season, caused partly by the condition of the water and partly by the withdrawal of a portion of the fish as explained further on. The season opens with a large catch, which continues into May, but then falls away until June, when scarcely any fish can be obtained. This circumstance is attributed by the fishermen chiefly to the formation of a slime on the bottom, which also covers the nets and makes it difficult to handle them. These conditions may persist for a week or two in July, when good fishing revives, especially in the deeper waters, in which the best catches of the year are made during August and September. The remainder of the season affords much poorer returns, as a whole, than the summer, due undoubtedly to the spawning run which takes a large proportion of the fish away from this region.

The two seasonal movements above referred to are both shoreward and towards the western end of the lake, and it is during their continuance that the pound net catch is made. The spring movement occurs mainly during the latter half of April and in May, although a few stragglers may be found in June. It is felt along both shores as far as the Bass Islands and Kingsville, Ont., but on the south side of the lake it is most pronounced, east of Ashtabula. It extends but a short distance on to the western platform, where only small and irregular catches are now obtained about the Bass Islands and Kelley's Island, although formerly they became more abundant there.

The fall movement is much heavier and much more widespread than the spring, and is actuated by the breeding instinct, which leads the fish to seek spawning grounds, to a large extent, at a great distance from their normal habitat. It begins on a small scale in September, during which month a few individuals are sometimes captured in the pound nets on the platform. It does not become pronounced, however, until in October, and, including the up and down run, continues through November and more or less into December, although very few fish are taken during the last-mentioned month. That is to say, the pound net catch seems to be obtained chiefly, if not almost entirely, from the up run, making it possible that the bulk of the down run keeps farther offshore. The fall run strikes in along both shores, the same as the spring, but at the western end of the lake the fish now become widely distributed over the platform, and a large number pass through the Detroit River into Lake St. Clair. There is considerable difference in the dates of the appearance of the fish at different places, especially on the platform, but this diversity is of only local significance. It is not improbable that during the western movement a certain proportion of the fish also proceed through the deeper waters until they reach the platform, but nothing positive has been learned regarding this matter, as the schools are never followed by the gill netters, as in the case of the herring.

After the whitefish reach their spawning grounds on the western platform, they give rise to an extensive local gill net fishery of very limited duration. During their passage up the Detroit River, mainly in the latter part of October and the early part

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of November, they are caught by means of seines, and in Lake St. Clair, a few are taken in the pound nets.

It is interesting to note that during the spawning period a large body of fish still remains in the deeper water, where the gill netters continue to take them, though in smaller quantities than in the summer and early fall.

Spawning.—The entire distribution of the spawning grounds of the whitefish in Lake Erie is not known. During the spawning season a part of the fish remain in their normal deep-water habitat, but it is not probable that they spawn there. The regular fall movement carries a very large body to the western platform, where many well-defined spawning grounds occur. These are chiefly rocky reefs and shoals, characterized in part by the water-worn surfaces of the common limestone of the region, the so-called honey-combed rock. Hard, gravelly and sandy bottoms in some places are also said to serve the same purpose, but this fact has not been entirely substantiated. The distribution of the grounds on the platform is from the neighbourhood of Kelley's Island to near the Michigan shore, on both sides of the boundary line. Some of the best known are two shoals north of Kelley's Island; the reefs and rocky shores about and in the neighbourhood of North Bass, Middle Bass, Rattlesnake and Green Islands; the reefs about the Hen and Chickens, Niagara Reef, and occasional patches off the mainland shores. The depth ranges mostly from about 4 to 20 feet, but is sometimes greater. It is in these places that the gill net fishing is carried on during the spawning time, and mainly here and in the Detroit River that the eggs have been obtained for the artificial propagation of the species. The fish taken in the Detroit River are mostly bound from Lake St. Clair, although the river itself is said to contain one or more spawning places.

It seems scarcely credible that the great stock of whitefish which has characterized the deeper waters, where the catch has many times exceeded that of all the remainder of the lake combined, can have been maintained solely through the agency of that body of fish which reaches the western platform, and it is possible that extensive spawning areas will sometime be discovered farther east. One small ground is known to be located between Dunkirk and Westfield, N.Y., and two others are reported off Port Dover and Port Burwell, Ont.

The spawning time varies somewhat in different years, dependent on the conditions of the weather, and also with respect to the locality. Our information on this subject is mainly limited to the platform, where the dates have been accurately determined in connection with fish-cultural operations, as follows: Ripe eggs have been obtained, but only rarely, as early as the latter part of October, the first being taken generally in the early part of November. Spawning may continue into the first week of December, but the last eggs are seldom secured later than December 1, generally a few days before that date. The bulk of the eggs have usually been obtained between the 10th and 25th of November, but sometimes beginning as early as the 5th or 6th and continuing as late as the 28th, which dates may be considered to mark the limitations of the main part of the spawning season. These figures are based on the averages for several years and for the different grounds where eggs are procured for the hatcheries. In any one place the bulk of the spawning may be, and generally is, completed in a much shorter space of time, from 5 to 10 days. They begin to fish for the hatcheries on the Detroit River in the latter part of October, but the fish are not then ripe and are penned until the eggs mature.

Size.—The general run of the whitefish taken in Lake Erie ranges from about $1\frac{1}{2}$ to 5 or 6 pounds, but seldom exceeds 4 or 5 pounds. This applies to all parts of the lake, but the average size may differ more or less in different places or in the catch by different kinds of apparatus. The species, however, attains a weight of 12 pounds and more, and some have been reported weighing as high as 20 pounds, but these extreme sizes are now practically extinct. Individuals weighing 8 or 9 pounds are considered very large for Lake Erie at the present time.

It has been impossible to ascertain satisfactorily the average size of the fish in the catch of any one fishery. In several fares landed by the gill net tugs at Dunkirk in August, 1894, the average by actual weight was found to be between $2\frac{1}{2}$ and

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3 pounds, only a very small number weighing as low as 1½ and 1¾ pounds while the largest weighed about 5 pounds. According to the statements of the fishermen, the average weight on the platform ranges all the way from 2½ to 4 pounds, these figures, which are only estimates, being based in part upon the pound net and in part upon the gill net catch.

The dealers would prefer to handle no whitefish weighing less than about 1½ pounds, and some would place the minimum size suitable for market as high as 2 pounds.

From the observations of fish-culturists, the smallest fish from which eggs may be obtained on this lake weigh from 1½ to 2 pounds. In that event the general catch of whitefish on Lake Erie may be expected not to include immature fish, and the minimum size desired for market would about correspond with their earliest mature size, 1½ to 2 pounds. It is questionable, however, especially in the case of a rapidly decreasing product, whether its extensive capture in the first year of maturity should be allowed.

It is claimed by some that very large quantities of immature whitefish are caught in certain places, but the evidence in respect to that matter lacks confirmation. According to the testimony, comparatively few whitefish weighing under 1½ pounds reached the platform, the number being somewhat larger in the spring than in the fall, but at no time great enough to make their capture a question for serious consideration. Nothing is definitely known regarding the general distribution and habits of the young, but they are supposed to remain chiefly in the deeper waters of the lake. Many are reported to be taken in the herring gill nets still in that region, and also in the pound nets on some parts of both the north and south shore, but the men actually concerned in those fisheries deny that the quantity is ever excessive. The subject is important and should be further investigated.

DECREASE.

There has been a great falling off in the abundance of the whitefish in Lake Erie since the early days of the fishery, as shown by both the statistics and the testimony of witnesses, its relative extent, as compared with the other species, being exceeded only by that of the sturgeon and catfishes. The history of the decrease in United States waters cannot accurately be told because of the incompleteness of the returns, but on the Canadian side figures are available for each of the past 26 years. The statistics which have been taken of the United States catch give the following totals for each of four years, viz:—

1880.....	Lbs.
1885.....	3,333,000
1890.....	3,531,000
1893.....	2,341,000
	1,292,000

The year 1885 shows a slight increase over 1880, and represents the maximum catch for which figures are extant. The reduction from that time was 34 per cent to 1890, and 63 per cent to 1893.

Analyzing the returns so as to locate the changes in the catch with respect to conditions surrounding the fishery in different parts of the lake, we obtain the results shown in the following table:—

	1885.	1890.	1893.
	Lbs.	Lbs.	Lbs.
From Vermillion westward	1,009,400	891,962	651,180
Ohio, east of Vermillion	373,000	373,620	287,944
Pennsylvania and New York.....	2,149,455	1,075,869	353,266

As brought out by this table, the percentages of decrease for 1890 and 1893 as compared with 1885, in each of the three districts named, have been as follows:

1. From Vermillion westward: 1890, 11 per cent; 1893, 35 per cent.
2. Ohio, east of Vermillion: 1890, none; 1893, 22 per cent.
3. Pennsylvania and New York: 1890, 49 per cent; 1893, 83 per cent.

The most extensive decrease has, therefore, been manifested in that part of the lake where the deep water gill netting has been the main feature, and where comparatively small amounts are obtained by pound nets. The next rate of decrease is at the western end of the lake, where the pound nets attain their maximum development as to numbers, and where, in 1893, the catch by gill nets on the spawning grounds was less than one-sixth the total catch of that district. The least decrease was shown by the central portion of the south shore, where the size of the catch is also smallest, where the pounds, the principal method of capture, are for the most part scattered and relatively few in number, and where the fishing season for whitefish is of shortest duration. They come on this shore only during a brief period in the course of their spring and fall migrations, a transient visitor, passing from or toward their normal place of habitat.

The figures discussed above represent the actual catch in the several years without reference to the amount of apparatus employed. From the early period of the fishery the number of pound nets and the quantity of gill netting increased rapidly and continuously, but the amount of each has been reduced in recent years. The number of pounds was very much greater in 1890 than in 1885, and there were at least 200 more in use in 1893 than in 1885. The decrease in the catch of whitefish by pound nets has, therefore, been coincident with a marked increase in the amount of apparatus. In 1890 the pound catch comprised 40 per cent of the entire catch by all methods, but in 1893 it had increased to 60 per cent, owing to the reduction in the quantity obtained by gill nets.

Much less explicit information is available respecting the gill net fishery at the eastern end of the lake. At one time, mainly before detailed statistics were taken the amount of whitefish gill netting employed from Erie, Pa., was very great, and the catch of whitefish by that means was very large, much exceeding that by all methods throughout the remainder of the lake. It is stated by local authorities, although the statistics fail to furnish the exact date, that the development of this fishery and the taking of a large catch continued to about 1885, when, owing to a rapid falling off in the abundance of the whitefish, most of the fishermen who had previously engaged in its capture turned their attention to the herring. As the fishery declined at Erie it was taken up at Dunkirk, where it has increased several fold since 1885, but most extensively since about 1890. The only other port from which deep water gill netting for whitefish is prosecuted by steamers is Ashtabula, Ohio, but it is there of slight importance compared with Erie and Dunkirk.

While the quantity of gill netting employed in the deeper water increased considerably between 1890 and 1893, the falling off in the catch of whitefish by that means between those dates amounted to 67 per cent, showing that the decrease continues and that the fishery is still being conducted on too large a scale.

The Canadian catch of whitefish, which has been made almost exclusively in pound nets, shows many and great fluctuations in amount during the period from 1872 to 1894, but during recent years the total annual catch has been larger, on an average, than in the earlier period of the fishery. This increased catch, however, has only been secured through a steady increase in the amount of apparatus employed, the proportionate annual catch to each pound net having declined almost continuously to the present time. This fact is strikingly illustrated by the following table, which gives the average annual catch per pound net for five year periods, except the last entry which covers only three years:

	Lbs.
1872 to 1876.....	10,036
1877 " 1881.....	4,160
1882 " 1886.....	2,678
1887 " 1891.....	1,723
1892 " 1894.....	1,151

DECREASE IN LAKE ST. CLAIR AND THE DETROIT RIVER.

The Canadian statistics show a marked decrease in the catch of whitefish in the Canadian waters of Lake St. Clair since 1889, and a greatly fluctuating catch previous to that date. There has also been a corresponding decrease on the Michigan side of the line. There is no standard by which to measure the extent or rate of this decrease, but as the fish which frequent these waters enter them from Lake Erie, and only during the spawning movement in the fall, it is natural to suppose that the extent of the run each year is influenced by the abundance of the fish in the larger lake.

OPINIONS OF THE FISHERMEN RESPECTING DECREASE.

All fishermen who have had a long experience in the fisheries of Lake Erie acknowledge that there has been a very marked decrease in the abundance of whitefish since early times. It is also quite universally agreed that this decrease has continued down to a comparatively recent date. Strangely enough, however, and in the face of the statistical returns, which they themselves have furnished, the figures being taken from their own books where such are kept, many of the fishermen are strongly of the opinion that during the last few years just preceding 1894 the average catch has remained constant or has even slightly increased. This result they attribute very generally to the work of the hatcheries. It is impossible to reconcile their views in this matter with the evidence above discussed, which undoubtedly has the greater weight of authority.

LAKE HERRING.

Status.—The herring (*Argyrosomus arctedi*) is by far the most abundant of the market species inhabiting Lake Erie, and the fishery to which it gives rise is much the most conspicuous one, as regards the extent of catch, on the entire chain of lakes. Since 1879, at least, the output annually from this lake alone has constituted from fifty to eighty per cent of the entire yield of herring from all the lakes combined, while within the limits of the lake itself, during the same period, the herring catch has composed from about thirty to sixty per cent of the total catch of all species. Moreover, notwithstanding its inferior price, the value of the catch annually has been equal to from thirty-three to forty per cent of the value of the total catch in Lake Erie.

This species first owed its prominence chiefly to the decrease in the whitefish, which induced the fishermen to make a special feature of its capture. In the early days of the fishery, the mesh in the pound nets was of sufficiently large size to permit the escape of herring, and the gill net mesh was mainly adapted to the whitefish. The improvements in facilities for transportation have also helped to stimulate the herring fishery, and the opportunities now afforded for preserving and shipping the catch long distances in a fresh condition have opened up an almost unlimited market. The cheapness of the product, which brings it within the means of the poorer classes, has also been one of the most important factors in producing this wide demand. Through these circumstances, the herring has come to have a more widely distributed market than any other of the lake species, and its preservation is considered to be of more moment to the fishermen of Lake Erie than that of any of the others. The fact that the herring run larger, as a rule, in Lake Erie than in the other lakes to the north and west, is likewise in its favour.

Distribution and movements.—The herring has the same general distribution and migratory habits as the whitefish, but seems to be more widely disseminated during most parts of the year. During the summer and winter it is mainly restricted to the deeper waters in the middle of the lake in its eastern half and along the northern shore east of Rondeau, although a small body is found in winter on the western platform.

From the deep water region of even temperature there are two great migrations into the shoaler and more changeable portions of the lake. In the spring when the shoal waters become warmer the fish emerge from their winter habitat and move shoreward and upon the edge of the platform, evidently in search of food. The volume of this migration is less than that of the fall run and is more fluctuating and irregular. The movement is felt along both shores as far west as Leamington and the eastern side of the Bass Islands, and the herring, therefore, constitute a considerable portion of the spring catch of the pound nets within the limits mentioned. Their presence is generally first noticed early in April and occasionally large lifts are made in the latter part of that month, although west of Vermillion and probably on other parts of the shore the best fishery is in May. Some herring are caught in June, but by the first of that month the bulk of them have left the United States coast for deeper water, although they remain on the Canadian shore east of Point Pelee throughout the summer.

During the summer months the gill net tugs from Cleveland and eastern ports find them in deep water well out in the lake, the best season off Erie, the principal seat of this fishery, being from the middle of July to the middle of September, the maximum catch being made in August.

The fall migration corresponds in a general way with that of the spring, although the incentive is different. The fall run is most pronounced and uniform in its movements on the shores west of Point Pelee and Vermillion. Large bodies of herring are seeking spawning grounds on the platform over which they become widely distributed, a small part of the schools also finding their way through the Detroit River into Lake St. Clair.

On the middle southern shore the fall movement is ill-defined and irregular, and the fishermen, theorizing upon this fact, suppose that the bulk of the fish move up the Canadian side of the lake until deflected by Point Pelee, many of the pound netters holding that the United States waters are so obstructed by gill nets that no other course is open. West of Vermillion and around the islands there was formerly and is still to some extent, a small run of large non-spawning fish during the latter half of September and early in October. The main fall run appears about or subsequent to the middle of October and continues until the latter part of November or into December, but the best fishing is obtained on the platform during November when the fish are spawning. While it is at its height there is a substantial falling off in the gill net catch in the deep water at the east, which is ample evidence that a large proportion of the herring in the lake take part in the migration.

Only indefinite information has been obtained of the return or eastward movement of the herring after spawning. Some of the eastern tugs which resort to the western end of the lake in the fall have been known to fish out of Huron as late as January, when some fish were still being caught.

In Lake St. Clair herring are caught at all seasons except the summer, but whether the spring fish are some which have remained after spawning in the preceding fall cannot be stated.

Spawning.—As shown above the herring, therefore, execute the same general spawning movements as the whitefish. The distribution of their spawning grounds on the platform, however, is less restricted, and they are unquestionably not confined to the reefs and rocky bottoms when discharging their eggs. There is also no doubt that spawning grounds of great extent occur east of the platform, although they have not been located. It would seem impossible for the comparatively small number of fish which have visited the western spawning grounds in recent years to have kept up the main supply on so large a scale, and it is stated that since the decrease began large bodies of herring have spawned off the south shore between Huron and Fairport, an event previously unheard of.

The spawning time of the herring is not as definitely known as in the case of the whitefish, with which, however, it agrees approximately. The bulk of the spawn is cast between about the 10th and the end of November, but some spawning may take place shortly before and after those dates.

Size.—The herring of Lake Erie are larger than those of either Lake Huron or Lake Superior. There is some variation, dependent upon the season. During the spawning run the fish taken at the western end of the lake average 11 or 12 ounces, but those obtained near Sandusky in September range from 11 to 25 ounces, the average having been about 19 ounces in 1894. The minimum weight of the herring marketed is about 8 ounces, but the average is everywhere larger than this. The pound netters on both the north and south shores record the capture of smaller fish at times and some are taken occasionally in the gill nets at the eastern end. The catch of under sized herring, however, is not of considerable proportions, and such fish are never put upon the market.

Decrease.—In that part of the lake west of Huron, the fishermen agree that there has been a decrease in the abundance of the herring, the most of them dating the beginning of the falling off in about 1890 or 1891. Regarding the middle section of the south shore there is a difference of opinion; while in Pennsylvania and New York all the fishermen interviewed, with one exception, refused to acknowledge the occurrence of a decrease, although admitting that more netting was required to catch the same quantity of fish.

The total herring catch by all methods in United States waters for the several years when the statistics were collected is shown in the following table:—

1880.....	11,774,400
1885.....	19,354,900
1890.....	38,868,283
1893.....	20,931,076

Considered as a whole, therefore, the herring catch increased in size until 1890 or thereabouts, the exact year not being determinable owing to the lack of figures for intermediate periods, having practically doubled in the course of each of the two half decades ending with that year. Having reached its maximum about 1890, it then fell off to the extent of nearly 50 per cent during the succeeding three years, the catch for 1893 having been almost identical with that for 1885.

Taking into consideration the extent of fishing in connection with the herring, we find that the number of pound nets in use was about 50 per cent greater in 1890 than in 1885, and was still about 30 per cent greater in 1893 than in 1885. Moreover, the amount of herring gill netting kept increasing at a comparatively rapid rate down to 1893. A much greater quantity of apparatus was, therefore, required to make in 1893 the same catch that was reported in 1885.

Analyzing the catches by districts we obtained the results presented in the following table, which shows the amounts taken on different parts of the United States coast during each of three years:—

	1885.	1890.	1893.
	Lbs.	Lbs.	Lbs.
1. From Vermillion westward.....	12,860,700	18,841,613	6,174,392
2. Vermillion to Conneaut.....	3,014,900	10,207,940	6,667,788
3. Pennsylvania and New York.....	3,480,200	9,819,630	8,088,896
Total.....	19,354,900	38,868,283	20,931,076

In the statistical investigations of 1890 and 1893, the catch of herring was enumerated separately for each of the two principal fishing methods, pound and trap nets on the one hand, and gill nets on the other. Only a relatively few thousand pounds of herring were taken by any other means. While a separate enumeration was not made in 1885, it is still possible to use the returns for that year to some extent in completing the comparisons made below.

The district west of Vermillion is the extensive pound net region. Here the total catch increased 50 per cent in 1890 as compared with 1885; but in 1893 it fell off 66 per cent as compared with 1890 and 50 per cent as compared with 1885. In 1885 practically all of the herring were obtained in pounds; in 1890 the catch by this method had increased 33 per cent, with at least an equal increase in the apparatus; while during the next three years the catch decreased 87 per cent with a decrease of not over 20 per cent in the number of pounds. Only a small quantity of gill nets was employed in this district in 1885, but in 1890 the catch by this means had reached over 2,000,000 pounds and in the next three years a further increase in the catch of 87 per cent had taken place. The increased catch by gill nets in recent years resulted from a vast increase in the apparatus, stimulated by the visits of tugs from eastern ports.

Between Vermillion and Conneaut there is only a moderate pound net fishery, but there has been a constantly increasing number of gill nets. We find here an increase of 233 per cent in the total catch between 1885 and 1890, but in 1893 there was a decrease of 40 per cent as compared with 1890 and an increase of 50 per cent as compared with 1885. In this district there was a decrease in the pound net catch between 1890 and 1893 of about 56 per cent, the amount of apparatus showing no diminution. The gill net catch also shows a decrease amounting to 24 per cent between 1890 and 1893, notwithstanding a heavy increase in the amount of netting.

In Pennsylvania and New York the catch of herring in pound nets is too insignificant to call for attention in this connection. The catch by means of gill nets, however, is very important, and this branch of the fishery shows a decrease of 17 per cent between 1890 and 1893, with a very considerable increase in the amount of netting used. The total catch increased greatly, however, between 1885 and 1893, owing to the change from the whitefish to the herring fishery, as explained above.

The conditions of the fishery in United States waters may be summarized as follows:—With an increase in the number of pound nets from 1885 to 1890, there was a large increase in the size of catch. From 1890 to 1893, with a reduction in the number of pound nets amounting to between 12 and 15 per cent, the catch fell off 81 per cent. There was a very large increase in the total gill net catch from 1885 to 1890, accompanying an increase of perhaps 40 per cent, more or less, in the amount of netting. In the three succeeding years the amount of gill netting continued to increase to the extent apparently of nearly 40 per cent, but during that time the catch began to fall off. It is evident that there has been a large decrease in the abundance of herring in Lake Erie. This decrease has been felt in all parts of the lake, but to the greatest extent by far in the extreme western part, where the greater proportion of the pound nets are located.

The heavy decrease or abrupt falling off in the catch began at Port Clinton in 1890, at Huron in 1891, and around the islands in 1892, although a smaller decrease was more or less manifest for a varying period preceding those dates.

On the Canadian side of the lake the fishery, both by gill nets and pounds, has always been small compared with the United States shore. The Canadian fishermen are of the general opinion that the herring has suffered no decrease except in one or two places, due to local causes.

The Canadian statistics show a steady increase in the total catch from 1869, when the first returns were made, until 1885, inclusive. Since then the increase in the pounds has been steady, amounting to 64 per cent in 1894. While the amount of gill netting has fluctuated, there has been, upon the whole, a steady increase which amounted, in 1894, to 661 per cent. In only four years since 1886 has the catch been greater than was recorded in that year, and an examination of the records shows that while the total catch during the period mentioned has been fairly maintained, this has been possible only through a great increase in the amount of apparatus.

The fall run of herring into the Detroit River and Lake St. Clair, was formerly very large, but it is now insignificant. The Canadian statistics indicate a falling off from 1,256,000 pounds in 1886, to 13,000 pounds in 1893.

WALL-EYED PIKE.

Status.—The fishermen of Lake Erie differentiate the wall-eyed pike (*Stizostedion vitreum*) into two varieties, the yellow or gray pike and the blue pike. These varieties are distinguished principally by their colour, but large individuals, even when of a decidedly blue colouration, are invariably ranked with the more valuable yellow pike, while the market makes practically no distinction between the small ones. The annual catch of the two varieties combined is exceeded in extent and value by that of the herring alone of all the species found in the lake.

Distribution and movements.—The wall-eyed pike is found throughout the entire extent of the shore line on both sides of the lake. It is generally stated that the yellow pike is most abundant on the western platform, from which the blue pike is said to be almost totally absent. The run of the large fish usually begins early in April and continues generally until May 1, lasting in abundance very rarely after May 15. A few are taken throughout the remainder of the spring and they also occur in small numbers in the fall. They are captured in small quantities by both the whitefish and herring gill netters of Erie and Dunkirk, chiefly in the spring, but also to some extent in summer and fall. About 80 per cent of the large fish recorded in the statistics as wall-eyed pike are caught in the pound nets.

To the eastward of the platform a run of smaller wall-eyed pike, usually classed as blue pike, occurs in the spring. They do not approach the shores closely enough to be taken in the pounds until about the middle of May, considerably later than the spawn run of "yellow pike," and they continue in greater or less abundance, according to locality, until the end of the spring season, and occur again in the early fall. The gill netters of Cleveland and eastward find the "blue pike" usually during the first two weeks in April, before the run reaches the pounds, and they continue to catch them irregularly until December. In the spring the best catches are made in gill nets in April and early May; they are again abundant in September or October, and the maximum for the year is reached in November. These fish, sold as blue pike, are smaller than the spring fish on the platform, but in their importance to the gill netters they are not exceeded by any other fish except the herring, with which they may be more or less associated in the spring.

Spawning.—The spawning grounds of the yellow pike occur in the bays and streams as well as upon the reefs and along the greater portion of the shore, but principally at the western end of the lake. The vicinity of Maumee Bay appears to be the most prolific spawning ground in Lake Erie, and the Thames River holds similar rank in the Lake St. Clair region. The eggs are deposited between the latter part of March and the early part of May, but mainly during April. There is no satisfactory evidence respecting the spawning of the "blue pike," although several fishermen claim to have witnessed it during the latter part of April and early in May.

Size.—The yellow pike ranges in size up to 15 and 18 pounds, but few such fish are caught. The first grade of fish comprises those weighing upwards from about 1 pound, the second grade includes fish between $\frac{1}{2}$ pound and pound, while the third grade embraces all below $\frac{1}{2}$ pound. The smaller grades are sometimes sold as "No. 2" and "No. 3," at others as saugers and again as "blue pike," according to the demands of the markets. On the Canadian side the average size is said to be larger.

The gill nets and hooks and lines take fish of a fair average size, but the other forms of apparatus catch a very large proportion of small fish, many weighing only 4 or 5 ounces, all of which are marketed.

The "blue pike" is said to be smaller than the "yellow," probably because the large ones are always designated under the latter name.

Decrease.—The fishermen at the western end of the lake claim that for several years prior to 1894 a decrease was noticed in the yellow pike, but in the spring of that year they were present upon some parts of the shore, especially in the vicinity of Maumee Bay, in as great quantities as ever.

Concerning the blue pike the weight of testimony is not indicative of a decrease although fluctuations have occurred from time to time. So lax is the discrimination and so dubious the distinction said to exist between the two varieties, that it is impracticable to attempt the discussion of it except as regards the species as a whole.

The statistics of the catch for three years in United States waters are as follows:—

	1885.	1890.	1893.
	Lbs.	Lbs.	Lbs.
From Vermillion westward.....	2,300,100	2,659,044	2,017,071
Vermillion to Conneaut.....	2,475,300	3,205,430	3,327,011
Pennsylvania and New York.....	5,800,225	3,730,162	2,560,720
	10,503,625	9,594,636	7,904,802

These returns show a decrease in the catch of about 25 per cent between 1885 and 1893, and of about 15 per cent between 1890 and 1893. That the decrease in the abundance of the species is greater will be understood when it is recalled that during the longer period mentioned there was a heavy increase in all kinds of apparatus in which the wall-eyed pike is captured. The falling off was greatest in the eastern part of the lake, while along the central part of the south shore there has been a considerable increase in the catch. In the spring of 1894 there was a heavy run of large yellow pike at the extreme western end of the lake, which made up the deficit above noted in that year, but as this influx was not elsewhere observed the fact does not invalidate the conclusion that there has been a general decrease in the species between 1885 and the present time.

On the Canadian shore there has been a steady increase in the size of the catch, due, however, to an increase in the amount of apparatus used.

SAUGER.

Status.—The sauger (*Stizostedion canadense*) stood third in the relative size of the catch made in the United States waters in 1885, 1890 and 1893, and in the last mentioned year it ranked fourth in the total value of the catch. Its status on the Canadian side is uncertain as it is not there enumerated separately in the statistics. The extent of the United States catch cannot be stated correctly owing to the habit of the fishermen of frequently including the small blue and yellow pike in the same category as the sauger.

In 1893 the pound nets took over 58 per cent of the total catch for the United States side, the balance being obtained by means of gill nets, seines, fyke nets and hooks and lines, named in the order of their importance in this fishery. Much of the catch credited to the pounds doubtless consisted of the wall-eyed pike, but what proportion cannot be told.

Distribution and movements.—The sauger is distributed along the entire shore of Lake Erie, but appears to be much less abundant in Canadian than in United States waters. It seems to belong essentially to the shoal waters, at least during such times as it is accessible to the fishermen, a fact exemplified by its abundance on the platform. During most of the year, however, the whereabouts of the bulk of the saugers is not known.

As soon as the ice leaves in the spring they are found in abundance on the platform and along the shore west of Vermillion, being at that time the object of an important gill net fishery. Gill netting for saugers begins at Vermillion and soon

after extends westward, a fact which leads the fishermen to the conclusion that there is a westward movement of the schools. This run, whatever may be its course, continues during the first three weeks in April, although the species is taken in small numbers in the pound nets until the close of the spring season. When the pounds get in early on the platform they are the means of obtaining large quantities. There is a smaller shoreward movement in the fall, and the pound nets in some places make good catches, although never so large as in spring. During the winter many are caught through the ice in the hook and line fishery on the western platform.

Spawning.—The extensive spring movement is undoubtedly connected with the passage of the fish to their spawning grounds, the extent of which is not accurately known. They undoubtedly spawn along the shores at the extreme western end of the lake, and it is supposed that they do so also in other shallow places on the platform as well as more sparingly further east. The exact time of spawning has not been determined, but the season is supposed to end by the middle or latter part of April.

Sizes.—The sauger rarely exceeds 1 1½ pounds in weight and 15 inches in length. The average size of the fish marketed is not over 11 to 13 inches or about ½ pound. The gill nets take a larger average size than the pound nets.

Decrease.—From the statistics it is impossible to determine if there has been a decrease in the abundance of this species. The catch in Canadian waters is not enumerated separately. With respect to United States waters, the largest catch (5,466,000 pounds), is recorded for 1885. The amount fell off to 4,179,000 pounds in 1890, notwithstanding that the quantity of apparatus had increased. In 1893 the catch was larger (4,531,000 pounds) than in 1890, although the number of pound nets was somewhat less than in the earlier year. There has, however, been a decided increase in the extent of the tug gill netting for this species, which may readily explain the larger catch in 1893, even though a decrease in abundance had taken place. In 1893 the catch by pound nets was 58 per cent of the total catch on the southern side of the lake. The species was taken in other kinds of apparatus as follows, in the order of the size of the catch: gill nets, seines, fyke nets and hooks and lines.

With very few exceptions, the testimony of the witnesses who were interviewed on this subject was to the effect that a decrease had taken place, but no one gave any definite information about it.

The difficulty in dealing with the statistics arises from the fact that a proper discrimination is not always made between this species and the smaller sizes of the yellow and blue pike, which are frequently lumped with it, all being recorded under one name, presumably that which at the time composes the main part of the catch, whether blue pike, No. 2 or 3 pickerel, or saugers. It is quite certain, however, that a decrease in the abundance of the species, as a whole, has taken place.

STURGEON.

Status.—The sturgeon (*Acipenser rubicundus*) is one of the higher priced fishes of the lake, its value being augmented by the importance of its secondary products, caviar and isinglass; the demand for it exceeds the supply and its capture, therefore, profitable to the fishermen. On the United States side the bulk of the catch is made in gill nets, 527,000 pounds, having been taken by that means in 1893, 178,000 pounds in pound nets and 88,000 pounds by hooks and lines.

Distribution and movements.—Practically all that is known respecting the movements of the sturgeon is that they resort to certain places in the spring for spawning purposes, and most of the catch is made at that season. They occur then along the entire shore, but are most abundant at the extreme eastern end of the lake, off Erie County, New York, where the catch since statistics have been taken has always exceeded that of all the remainder of the United States shore. Outside of this locality they are now most plentiful on the Canadian side, where the catch has been

better maintained. The vicinity of Point Pelee and Pelee Island has been the most favoured one in Canadian waters. They enter Detroit River in the spring and at the same season occur in some numbers in Lake St. Clair. Many are taken on the Canadian shore of Lake Erie in summer, but the fall catch is everywhere smaller than the spring. Their whereabouts in winter is not known, but they are occasionally caught on hooks and lines fished through the ice.

Sturgeon are taken by means of pound nets, gill nets, seines, and baited and naked hooks. Pound nets were formerly the most important of the appliances employed for their capture, but since 1885, at least, more than half of the annual yield of Lake Erie has been taken by means of gill nets off the shores of Erie County, New York. The localities in which the sturgeon is taken by other means are discussed in connection with the apparatus and fishing methods.

Spawning.—The spawning season begins early in May and continues into June. The exact location and extent of the spawning grounds are not known, but some parts of Lake St. Clair the lower portion of the Detroit River, the vicinity of Point Pelee and Pelee Island, and the shores of Erie County, New York, appear to be resorted to for that purpose. It is probable that fish under 4 feet in length do not spawn.

Sizes.—The maximum size of the sturgeon in Lake Erie is about 150 pounds, but individuals weighing from 90 to 100 pounds are considered large at the present time, and the average good-sized fish weigh about 60 pounds. The market recognizes two sizes, those over 4 feet long and those under that length, the latter being known as "halves" and bringing only half price. In some places and at some times, at least the "halves" compose from one-third to one-half the pound net catch.

Decrease.—The sturgeon has suffered a relatively greater decrease in abundance than any other species in the lake. In the early history of the pound net fishery they were caught in vast quantities, but being in no demand they were regarded as a nuisance and destroyed wholesale.

The statistics of the Canadian catch antedate those of the United States, the species being first recorded in the former in 1879. From that time until 1887 there was a yearly increase, but subsequently there has been a nearly steady decrease, coincident with an increase in the number of pound nets from 143, in 1887, to 204, in 1894. Comparing the catch of the pound nets during the four years 1887 to 1890, with the similar period ending with 1894, we find that the catch per net has decreased 36 per cent. On the United States side the decrease has been greater, the catch falling from 4,727,956 pounds, in 1885, to 2,073,907 pounds, in 1890, and 793,800 pounds, in 1893, a total decrease of 83 per cent during the entire period. The decrease has been manifested in all parts of the lake, but was greatest in amount if not in proportion in Erie County, New York. There has been a heavy decrease in the Detroit River and Lake St. Clair, but owing to the irregularity of the fishing methods there employed it is impossible to estimate its extent.

BLACK BASS.

Status.—From a commercial standpoint the black bass is of very little importance in Lake Erie, and it demands attention in this connection, principally on account of its qualities as a game fish.

Distribution and Movements.—In the fall, and perhaps to some extent in the spring and summer, the black bass appears to be somewhat gregarious, and it occasionally happens that at such times large catches are made in the various forms of fixed apparatus, pounds, trap nets and fyke nets. The sport fishing is carried on principally in the early summer when the larger and finer fish are caught, but there is some angling also in the fall. There are no definite migrations of this species, but there is a movement of small and medium sized fish along shore in certain places.

The black bass is found in all parts of the lake and in most of the waters tributary thereto. In the streams, bays and marshes the large-mouthed species occurs, but the small-mouthed species is confined to the lake proper.

Spawning.—The black bass spawns in shoal waters during the spring and early summer, the large mouthed in the streams and pools in the marshes and bays, the other species around the shores of the lake. With the latter the season appears to begin in the latter part of May and to continue until July 1, the large-mouthed bass spawning somewhat earlier. The breeding fish form shallow saucer-shaped depressions or nests in which the eggs are deposited, the parent remaining on guard until the young are hatched. The fish are readily captured at such times by seines, "snags," spears, and other poaching methods. The young remain in shoal water for a considerable time, and we saw specimens from 2 to 5 inches long caught in the minnow seines in August, although they are apparently not used for bait.

Size.—The fish caught by the sportsmen in the island region average from 12 to 16 ounces, while those taken by the pound net men weigh from 16 to 18 ounces on an average. More fish under 8 ounces in weight were seen in the sportsmen's strings than in the catch of the pound nets. The size is said to be decreasing.

Decrease.—The decrease in the abundance of black bass in Lake Erie has been extensive. Formerly large catches were made in various forms of fixed apparatus, but such are now rare. In the statistics for 1885 the black bass were not separately enumerated, but the subsequent returns show a reduction from 248,418 pounds in 1890, to 105,602 pounds in 1893, a falling off of over 42 per cent in three years. The decrease per unit of apparatus during this period was 50 per cent in the pounds, 40 per cent in the fykes and 60 per cent in the seines. On the Canadian side we find a decrease of about 50 per cent in the catch of bass per pound net between the four year periods ending with 1886 and 1894 respectively, and still greater changes would be shown by a comparison with earlier years.

Detroit River, Lake and River St. Clair.—On the Detroit River some bass are caught on hooks and lines, and a few in seines with the whitefish. In Lake St. Clair, they are obtained principally in seines, but also in fyke nets, and, to a limited extent, in pound nets. On the River St. Clair, seines are the principal means of capture, although some are speared on their spawning beds by Indians and others. In the vicinity of Algona and the St. Clair Flats, there is a rather extensive hook and line fishery by sportsmen, a very large proportion of the catch consisting of the large-mouthed bass.

MISCELLANEOUS FISHES.

Catfishes and bullheads.—The catfishes caught for market on Lake Erie are the silver or spotted cat, *Ictalurus punctatus*, and the yellow cat, *Ameiurus lacustris*; the bullhead is the *Ameiurus nebulosus*, and is considered inferior to the former two. Most of the catfishes are taken by hook and line and by the pound nets, but the greater part of the bullheads is secured by means of fyke nets and seines. The hook and line fishery for the catfishes was formerly of considerable importance, but of late years both species have fallen off greatly in abundance, making the fishery much less remunerative, and fewer men now engage in it.

In United States waters, the decrease of the catfishes has exceeded that of any other species with the single exception of the sturgeon. Statements to this effect were made at practically all of the fishing stations on the south shore, the depletion in many cases being such as virtually to amount to the extermination of the species for commercial purposes. The statistics tend to confirm the testimony of the fishermen, the figures of the catch showing a decrease of over 72 per cent from 1885 to 1893. From 1890 to 1893, the decrease averaged about 57 per cent for each of the fishing methods employed. The depletion has been quite uniform for the entire United States shore, with the exception of Chautauqua County, N.Y., where a slight increase in the catch was observed.

Lake Trout.—This species affords only a very limited fishery in Lake Erie, and is practically confined to the deep water of Pennsylvania and the western extremity of New York. Almost the entire catch is made by tugs from Dunkirk, but small quantities are obtained by vessels from Erie, Ashtabula and Fairport. Gill nets having a $5\frac{1}{2}$ inch mesh are used specially for the trout, but a few are taken occasionally in the whitefish gill nets, and very rarely one may enter the pound nets. During the spring and summer they seem to be scattered over the deep water area near the eastern end of the lake, but in October they begin to collect in a body preparatory to spawning, and in that month and until the middle of December the entire catch is made. There is a spawning reef located near the shore between Dunkirk and Westfield, N.Y.

The trout are said by some of the fishermen to have been much more abundant at one time than they are now, but their statements lack confirmation. There appears to have been a recent decrease, however, which the statistics indicate to have amounted to 23 per cent in 1893 as compared with 1885.

Yellow Perch.—This species is very abundant and furnishes a large catch, but it is not held in much esteem by the fishermen. It is one of two species which show a large increase in the amount sent to market between 1885 and 1893, but this has undoubtedly been due to an increased demand rather than an actual increase in abundance. The perch is one of the most rapacious of the lake fishes, and feeds extensively on the young of other food species. There is, therefore, no demand for its protection.

Miscellaneous.—The remaining species taken in the fisheries of Lake Erie, the white bass, the various species of the sunfish family, grass pike, maskinonge, suckers, sheepshead, carp, etc., do not require to be discussed in detail in this connection.

FISHING METHODS AND PRACTICES.

The diversity of conditions existing in Lake Erie, together with the great variety of its food fishes, has led to the employment in its waters of a diversity of fishing methods. The principal ones are represented by the pound nets and gill nets, the former typical of the sedentary apparatus and suited only to the shallow margins and the platform, the latter changing constantly in position and chiefly made use of in the deeper waters. The bulk of all the catch has, for many years, been secured through the agency of these appliances, which may be said to combine the requisites for reaching practically every part of the lake's resources. The other means of capture are advantageous under certain, and generally limited conditions, and their chief merit among the fishermen in most cases is the inexpensiveness of the outfit. Such are the trap nets, fyke nets, seines, and hooks and lines. The trap nets are used in about the same character of location as the pounds; but they are smaller than the latter, and may readily be moved from place to place. The fyke nets are mainly adapted to inclosed waters and marshy areas; they are often built of larger size than is customary elsewhere, which greatly increases their capacity. Seines are now employed on only a very small scale in some of the bays and rivers, but found especially effective during the spawning run in certain of the latter. Hook and line fishing is mainly carried on at the two ends of the lake, both hand-lines and set-lines being utilized. The use of spears has never been extensive, and scarcely anything is now done by this means.

POUND NETS.

Description.—The pound nets consist each of a leader, heart, tunnel and crib, composed of netting, which is usually supported on stakes driven into the bottom. The leader is a straight barrier running off from the shore and serving to intercept the fish and direct them toward the opening into the crib, which they reach through the heart and tunnel. The crib is square, and is inclosed at the bottom and on all sides except at the point of entrance.

The pounds are set either singly, or, more usually, in strings of two or more, with the inner end of each succeeding leader starting from the back of the next inner crib. On the United States side of the lake there are several such strings, forming practically continuous barriers 5 miles in length, and reaching from 6 to $7\frac{1}{2}$ miles from shore. Sometimes, as in the island region, on the platform the inner end of the inshore leader is attached to the shore, but there is usually an interval of from 10 rods to 2 miles, according to location. As a rule, the inshore leader is longer than the others, and may vary from 50 to 175 rods in length.

In Maumee Bay and Sandusky Bay the leaders are usually about 30 rods long, but elsewhere, excepting the inshore one, they vary from 40 to 70 rods in length, although a few are more extensive. There is at present a tendency to use shorter leaders, and 50 rods now appears to be the most approved length. As the leader is designed to extend from the surface to the bottom, its depth is, of course, adapted to the depth of water in which it is fished. The diameter of the crib bays, and the larger ones, from 24 to 30 feet square in the more open waters of the lake. The cribs have about the same depth as the water where they are used, varying from 6 feet to 8 or 9 fathoms.

The mesh in the leaders measures mainly from 6 to 7 inches, the extreme range being from 4 to 8 inches. There is now a tendency, however, to increase the size, and most of the new nets in the island region have 8-inch leaders, which fish as well as the smaller ones, besides being cheaper and holding more readily in a current. The hearts and tunnels have usually a 4 or 5-inch mesh. On the Michigan shore the mesh in the cribs is generally $2\frac{1}{2}$ inches, although a few are reported to have a larger size. East of Maumee Bay the customary sizes are $2\frac{1}{8}$ and $2\frac{1}{4}$ inches. The figures given above represent in all cases the new netting, but in tarring and during use the twine shrinks to such an extent that there are probably few cribs in any part of Lake Erie in which the mesh measures over 2 inches in extension, and in many it is as small as $1\frac{1}{2}$ inches.

On the Canadian shore the pound nets are constructed essentially the same as in United States waters.

In Lake St. Clair the length of the leaders varies from 20 to 100 rods, the majority being between 50 and 70 rods long. The mesh measures from 6 to 8 inches in the leaders, from 4 to 5 inches in the hearts and tunnels, from 2 to $3\frac{1}{2}$ inches in the cribs.

History, number and distribution.—Pound nets were used for the first time in Lake Erie about 1850, being built almost simultaneously in Maumee Bay and in Sandusky Bay. During the 20 years following the introduction of this method of fishing the increase in the number of pound nets was slow, especially to the east of Port Clinton. Misunderstanding as to the status of the owners of the shores in the matter of riparian rights deterred the fishermen from entering upon the fishery with the vigour which they afterwards displayed but after the question was decided by the courts in 1871 the industry grew rapidly.

There is no record of the number of pound nets fished in Lake Erie prior to 1880, but in that year the number was placed at 758, more than half of them being located west of Port Clinton, Ohio. The first detailed statistical survey of the lake was made in 1885, when at various seasons no less than 1,147 pound nets were in use, and we have estimated that 1,050 of these were employed during the fall, the season of greatest general activity in this fishery.

The pound net fishery, especially in the vicinity of Huron and Sandusky and on the Michigan shore, appears to have reached its climax about 1890, at which time, however, many of the fishermen were so heavily in debt that they were compelled to sell out to the dealers who were generally their creditors. This caused a reduction in the number of pounds, although a few of the fishermen have since increased the amount of their twine in an endeavour to compensate for the falling off in the average catch. After a thorough consideration of the subject, we consider it fair to assume that about 1890 there were from 1,500 to 1,600 pounds fished on the United States side of the lake during the fall season, a somewhat smaller number being used

in the spring. In the fall of 1893 the number was 1,296, and in the spring of 1894, 944. In 1894 there appeared to be a tendency to further reduce the quantity near Sandusky, but, on the other hand, a number of fishermen between the Detroit River and Locust Point contemplated adding to their outfits.

Briefly then, the number of pounds fished in United States waters in the fall of 1893 was about 250 more than during the corresponding season of 1885, and from 200 to 300 less than in the autumn of 1890.

Most of the pound nets on the United States side are located west of Cleveland. The western part of the lake is pre-eminently a pound net region, the character of the bottom and the depth of water being best suited to that form of apparatus. On the platform lying west of a line drawn from Sandusky to Point Pelee the conditions are such that pound nets may be built almost anywhere without reference to the land, and this fact has made it possible to place them in close proximity to the off-shore reefs on which the whitefish spawn.

It is upon this platform and upon the gradually sloping main shore between it and Avon Point that we found the longest strings of pounds. One near Locust Point containing thirty-two nets, and another near Huron had thirty nets in a line, the outermost being seven and a half miles from shore. There are others almost as long. East of Cleveland there have never been many pounds, and the conditions are such that there never will be nearly as many as further west. This part of the lake is better adapted to gill net fishing.

On the Canadian side pound nets were introduced later than on the other shore, and they have never assumed anything like the importance which they have reached in the United States. They are located mainly around Pelee Island and along the shore west of Long Island, although a few are scattered eastward as far as Point Abino. The longest strings are between Port Stanley and Point Pelee, where, in 1893, there were eight stands of three pounds each and 13 of two each, the others being set singly.

The number of Canadian pounds licensed at different periods since 1880 is as follows: 1880, 54; 1885, 132; 1890, 197; 1894, 204. The first licenses were granted in 1869, and since then the number has grown steadily.

Seasons.—The pound net fishery on Lake Erie is confined to two distinct seasons spring and fall, separated by intervals of several months. The summer close season is conditioned by the absence of fish along shore at that time and by the deleterious effect of the warm water upon the twine. The state of Ohio prohibits fishing with nets between June 15 and September 15, a period when the pounds would not be used even if the fishery were legalized. The winter close season, extending from the latter part of November to about April 1, has received no legal sanction anywhere on the lake, being enforced only by the appearance of ice or by the apprehension thereof.

The time of beginning in the spring is determined by the condition of the weather, the aim of the fishermen being to set their twine as soon as possible after the ice has left. The seasons vary greatly from year to year, but on the United States shore April 1 appears to be the average date of commencement. In most parts of the lake the nets are removed from about June 19 to 15, but on the Michigan shore many are taken out by May 1. With the exception of Maumee Bay, the southern part of the Michigan shore and Pennsylvania, fewer nets and shorter strings are fished in the spring than in the fall.

In the fall the time of starting is fairly regular, although it may vary slightly, owing to the whim or judgment of the fishermen. In Ohio, as before mentioned, the law forbids fishing before September 15, and in the other states they conform voluntarily to same general season. As some time is required to set the nets, it is usually nearly October 1 before fishing fairly begins. The nets are usually placed further from shore in the fall, or, at least, the strings are then extended, as at that season the principal aim is to catch whitefish and herring which remain further out in the lake.

In Canada no summer close season is observed except west of Point Pelee; the law does not require it and the water is generally so much colder on the north side

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of the lake that the twine is not seriously affected. The nets are usually set during April, and fish, with one or two interruptions for tarring, until November 1, a close season having been enforced during that month for the protection of the whitefish since 1892. Previous thereto, the fishermen were required to return to the water all whitefish caught during November.

Character of catch—From end to end of the United States shore the sauger is the first species caught in the pounds in the spring. The heaviest catch of this species takes place in the vicinity of Maumee Bay and thence eastward as far as Ottawa City. In this district practically nothing else is taken until April 15, but in the island region a considerable quantity of perch is obtained with the saugers. East of the platform the sauger catch is not so important, although large numbers often occur as far east as Cleveland. After the sauger, and frequently mixed with them in the latter part of April, there is a run of wall-eyed pike throughout the entire platform region, where it is the most important species taken in the spring fishery, especially between Monroe and Port Clinton. The heaviest run occurs in the latter part of April and early in May. From Sandusky and Kelley's Island eastward the blue pike appear in limited numbers in April, but do not reach the maximum until the latter part of May and in June. They are usually still abundant when the twine is taken out.

On the east side of the Bass Islands and at Kelley's Island small quantities of whitefish and herring occur during May and early June. This run appears to extend as far east as Dunkirk at least. Between Sandusky and Cleveland the herring fill in the gap between the saugers and the heavy run of blue pike, but east of Cleveland the herring and blue pike occur together, sometimes the one and sometimes the other predominating from day to day. In the latter region the whitefish occur in somewhat limited numbers from April to the end of fishing, being more abundant near Erie than elsewhere.

The four species mentioned are the important ones taken in the spring, but a number of less valuable ones are mixed with them. Among these may be mentioned, white bass, sheepshead, sunfish, perch, suckers, carp, black bass, etc. At Pointe Mouillee, Mich., and in Pennsylvania and New York the sturgeon is taken in the pounds more frequently than elsewhere on the United States side.

The first lifts of the pound nets in the fall reveal a miscellaneous assortment of fish, most of the species being of little value. Named somewhat in the order of their abundance these are sheepshead, wall-eyed pike or blue pike, perch, white bass, suckers, carp and saugers. The catch of small wall-eyed pike and blue pike is very large, and fewer large ones are caught than in the spring. In some places, as in Maumee Bay, there is often a good run of saugers late in the season, and on some parts of the Michigan shore the wall-eyed pike was the most important species in the fall of 1893.

The important fall fishery, the one which was formerly expected and now hoped for, is that for herring and whitefish. West of Cleveland a few straggling bodies of herring are usually caught prior to October 15, after which they gradually increase in abundance, but it is not until the first week of November that the maximum is reached. In a general way, it may be said that the heaviest run occurs between November 5 and 25, although the time varies somewhat with the locality and the season. The herring catch at the western end of the lake has been a failure for some years. East of Cleveland comparatively few herring are obtained in the pound nets in the fall.

On the platform and at Huron and Vermillion, a few whitefish are taken in October, but the heaviest run comes on in November, when this species passes westward to spawn on the platform. East of Cleveland the whitefish catch in the pounds is irregular, but in a few places good hauls are occasionally made.

On the Canadian shore, as far west as the vicinity of Rondeau, the herring appears to be the principal species taken in the pound nets throughout the year, but west of Point Pelee they are caught but sparingly in the spring and usually not at all in the summer. In the platform region good runs sometimes occur in October, but the heaviest bodies are present during November when the pounds are not

fished. The wall-eyed pike is an important fish along the entire shore, and on the platform it supplants the herring as the dominant species in the pound net catch. Most of them caught before 1st July and after 1st September, being most abundant west of Point Pelee in the spring. Whitefish are taken in limited quantities along the whole shore and at all seasons, but mostly in the fall, although the November close season interrupts the catch of this species.

At Port Dover, Rondeau, Point Pelee and other places, sturgeon are obtained in some numbers during June, July, August and September. This species was formerly exceedingly abundant. The sauger is of comparatively little importance on the Canadian shore, and the miscellaneous fish are about the same as are taken in United States waters.

Catch in Lake St. Clair.—In Lake St. Clair the nets are fished during an average season, from 20th April to 20th June, and from 20th September to 20th November, on the Michigan shore; and from 20th April to 1st November, with an interval in summer, on the Canadian side.

The first species taken in the spring are wall-eyed pike, red horse, sturgeon, herring and perch. Near the discharge of the lake the sturgeon is the most valuable fish caught at that season, although they are much less abundant than formerly. Comparatively few herring are now obtained, although they were once common, and the whitefish catch is small. In the northern part of the lake the most important species are perch and pickerel, catfish, mullet, red horse, sturgeon, black bass and white bass.

At the southern end of the lake red horse are often extremely abundant in the fall, but as the water grows cooler wall-eyed pike and whitefish are taken. The latter comes about October 15 and remains about three weeks, some of them spawning towards the end of their stay. Herring are now rarely caught and the sturgeon is less abundant than in spring. The catch of miscellaneous fish is similar to that of the spring fishery.

Relations of Mesh to size of Fish.—The regular mesh used in the pounds is such that large numbers of small fish are taken, the principal commercial species which suffer in this respect being the pike-perches and the catfishes. In 1894 a detailed examination was made of the character of the catch on the United States shore from Toledo to Vermillion, including the island regions, and on the Canadian shore between Point Pelee and Rondeau. In all of these places great quantities of small wall-eyed pike are taken. On the Canadian side the majority of these weighed between 8 and 11 ounces, and at least 15 per cent were as small as from 2 to 5 ounces. On the United States shore the average was about 8 ounces in all places where observations were made during September, and at Huron at least, there was no increase in the average weight up to the end of the season. In Sandusky Bay large numbers of small catfish, weighing 6 or 7 ounces each, are caught in the bay pounds. The most of them are thrown overboard alive, but many are inevitably destroyed, as we had opportunity to witness.

Many small fish of other species are taken, and we were told that young whitefish are caught to some extent in the pound nets off Erie in the spring, but we were not on the ground at the proper time to determine the validity of this assertion. One lot of sturgeon from between Point Pelee and Rondeau, consisted of 81 fish over 4 feet in length and 30 under 4 feet long, and the capture of these small ones is constant in most places where pound nets are used.

To prevent the capture of these small fish several methods of regulation have been suggested. The gill net fishermen almost universally propose that the mesh in the cribs of the pounds be increased, and the pound net men quite generally oppose such a measure. The latter base their objections upon the ground that the small fish, in their efforts to escape, would gill, and that, furthermore, were the mesh made large enough to permit the escape of young wall-eyed pike, it would also be large enough to permit the escape of the adults of some other species, as for instance, the sauger.

The testimony upon this subject was voluminous and contradictory, and in order to reach conclusions based upon definite data an experimental net was fished at Huron in the fall of 1894, through the courtesy of the Wickham Company, and at Kelley's Island in the following spring, through the kindness of the Sandusky Fish Company, the observations in both cases being made by a representative of the United States Fish Commission. The net was similar to those regularly in use, except that the crib had a mesh of $2\frac{1}{2}$, 3, and $3\frac{3}{8}$ inches in the back and two sides respectively.

In both localities it was demonstrated beyond doubt that this net would liberate most of the small fish, particularly the pike-perches, which would have been retained in cribs of the usual dimensions. It was found, however, that some of the mesh used by too large as a one-pound wall-eyed pike could escape through it. The chief objection to the net, however, was the large number of fish which gilled in it, especially in the larger meshes. This was particularly true of the herring, for whereas the regular nets gilled but one-eighth per cent of the catch, the experimental net gilled 49 per cent. In the case of the wall-eyed pike, it was not quite so bad, but it was found that the relative proportions of gilled fish were 3.1 per cent, and 40 per cent respectively, although in this case such a comparison is hardly a fair one because the special net liberated more of the fish which entered it. Assuming that the number of wall-eyed pike entering the two nets was the same, gilling was $2\frac{1}{2}$ times as bad in the special net as it was in the regular one.

We find that most of the herring entered the mesh during lifting, but in the case of all other species the majority entered before the net was lifted. The fish gilled in the regular net were all small, those gilled in the special net were nearly all of reasonable size for marketing, though the herring were often so injured and discoloured as to make them objectionable to dealers and consumers. It was found that when heavy lifts of herring were made the proportionate number gilled was larger than when the lifts were smaller, and had the fishery reached the dimensions of former years, the facts collected would have been still more adverse to the employment of a larger mesh than $2\frac{1}{2}$ inches. The compulsory use of such a mesh would amount to a total prohibition of pound netting in most parts of the lake, as the time occupied in extracting the fish from the meshes would inordinately increase the cost of operation. Whether a $2\frac{1}{2}$ -inch mesh could be used profitably and conveniently was not demonstrated, and we, therefore, consider it inexpedient, in the present state of our knowledge, to require a mesh of more than $2\frac{1}{2}$ inches in the cribs of pounds and other fixed apparatus.

Actual trial by fish commission representative shows that even where a man is especially detailed for the purpose, it is impossible to promptly sort out the small fish from a large pound net catch. It is, therefore, impossible to return the fish to the water in a living condition even should the fishermen have the best of intentions in that respect. If the landing of undersized fish were prohibited, they would be sorted out at a time when it best suited the convenience of the fishermen, which would inevitably be too late to allow more than a very small number of the young to live, the very object of the regulation being, therefore, defeated.

Time between lifting and condition of catch.—The pound nets are lifted or fished daily excepting during stormy weather, when the boats are unable to go out. In general, the catch is secured in good condition, practically all of the fish being alive when taken into the boat, but in bad weather there are occasionally some dead ones, and after a storm sufficiently severe to dismantle the net, the proportion is often considerable. Such extreme cases, however, are rare.

GILL NETS.

Gill nets are employed on Lake Erie chiefly for the capture of whitefish, herring, pike-perches and sturgeon, but other species are taken incidentally in the same connection, and special fisheries of minor extent are carried on for the lake trout and German carp. Practically three classes of these nets, based on the size of

mesh, are recognized, namely, a small meshed net adapted to the herring and pike-perches; a net of medium-sized mesh suited to the whitefish, and a large meshed net for the sturgeon. The several branches of the fishery will be discussed in accordance with that classification.

SMALL-MESHED GILL NETS.

Description.—The small-meshed nets are used in Lake Erie for herring, saugers, wall-eyed pike, etc. They usually have a mesh measuring from 3 to 3½ inches in extension. On the United States side the more common size is 3½ inches while in Canada the minimum size is fixed by law at 3 inches, but probably many nets having a smaller mesh than 3 inches are actually employed on both sides of the lake. Being constructed of linen there is little if any shrinkage in the twine. The length of individual nets varies from 200 to 400 feet, the longer sizes having come into use in recent years. They are about 20 meshes deep, hanging between 3 and 4 feet when set, and are now invariably furnished with corks and leads.

The tugs are generally provided with three gangs of nets, of which, during cold weather, two are fishing and one is ashore drying on the reels. One gang is lifted each day and taken ashore, being replaced by a dry one, so that each fishes two days before being lifted. In the summer when the fish die and spoil more rapidly, only one gang is fished at a time, so that each net is lifted every day and the captured fish are brought more promptly to market. The tugs fish from four to six miles of netting in a gang, so that in cool weather they will have, on an average, from eight to twelve miles of netting in the water at all times.

The boat rigs are more variable in size, but in general they use about one-half as much netting as the tugs fishing in the same region. On account of their dependence upon sail power, the boats remain closer to the shore and consequently have a shorter season, owing to their inability to follow the fish to the deeper parts of the lake. The fishing grounds of the tugs varies, with the position of the fish, from within a few miles of land to well out in the lake.

In all cases the nets are set on the bottom and the fishermen depend upon actual trial to locate the schools, there being no surface indications of their presence.

History, quantity and distribution.—The small mesh gill net fishery is of recent development as compared with the fishery for whitefish. Its statistical history is difficult to trace owing to the different bases upon which the returns have been made in different years, but in this connection we are principally interested in its present magnitude and in the question of its increase since 1885.

The irregularities in the seasons at different places render it impossible to state with accuracy the number of nets fished at any given time, but the largest number which it was possible to fish under the conditions prevailing on the United States side in 1893, is estimated at about 5,750,000 feet, of which 3,750,000 feet are allowed to the tugs and 2,000,000 to the boats.

In 1893 the number of tugs was 77, but in 1890 there were probably only about one-half as many, and the number of small boats was probably about the same. Upon this basis the number of nets fished in the two years would be about as follows:—

1890.....	3,875,000 feet.
1893.....	5,750,000 "

This makes an increase of about 48 per cent between the years mentioned, an estimate which is probably not too large when we consider that there was, during the same period, a tendency to increase the size of the rigs fished by each tug. Between 1885 and 1890 there was also a large increase, but its extent cannot be stated even approximately.

The amount of gill netting used in Canadian waters since 1884 has varied irregularly from 50,000 to 270,000 feet. The increase has not been a steady

one, although there were more nets in 1894 than ever before, and since 1889 there have never been less than 127,000 feet. No tugs are used in gill netting on that side of the lake.

Considering the lake as a whole, a conservative estimate would place the small mesh netting in 1893 at double the amount used in 1885. This fishery is carried on from practically all fishing points on the United States shore, but is most extensive in the region east of the platform. In the ports adjacent to the platform there were 34 tugs fishing in 1893, while east of that region there were 43, the nets being in about the proportion of 5 to 7. The foregoing figures, however, do not fairly represent the relative importance of the two regions, as the nets are fished during a longer season at the east than at the west end of the lake, the total number of months fishing by the tugs being equivalent to 107 and 300 respectively. The difference in the boat fishery of the two regions is still more pronounced in favour of the east, although the relations cannot be statistically expressed. Erie is by far the most important gill net centre, followed by Cleveland, Sandusky and Dunkirk, in the order named.

The boats on both sides of the lake usually fish near home, but the tugs change their headquarters from time to time in accordance with the change in position of the body of the fish. It follows, that in the spring, and, to some extent in the summer, tugs from various ports between Toledo and Cleveland move down to the vicinity of Erie, while in the fall and during open winters eastern tugs may be found fishing out of Huron, Sandusky and Port Clinton.

In general, however, it may be said that while the region west of Huron is pre-eminently a pound net region, these portions of the lake east of that place are best adapted to gill nets and are the seat of the most important fishery by that means.

Seasons and catch.—Early in the spring an important gill net fishery, of short duration, is carried on for saugers, perch and wall-eyed pike. It begins as soon as the lake is clear of ice and continues to about the latter part of April, when a sufficient number of pounds have been set to supply fresh fish for market. The principal seat of this fishery is west of Vermillion, but in a less regular manner it extends further east. Saugers constitute the bulk of the catch between Toledo and Vermillion; on the Michigan shore and east of Vermillion wall-eyed pike are the most important species, while the perch is taken in greater or less abundance along the entire shore. This fishery is carried on by professional and semi-professional fishermen, farmers and boys, using small boats, and by tugs which may come to the west end from all parts of the lake.

A few herring are caught at Kelley's Island and Vermillion in the spring after the saugers leave, but in general the spring catch of this species is unimportant west of Cleveland. In the western end of the lake there is no important gill net fishery subsequent to the sauger run until fall, but at Cleveland and eastward the fishery with small mesh nets continues almost uninterruptedly throughout the open portion of the year, blue pike and herring being the principal species taken.

The spring fishery for herring is quite important, commencing about April 10 and lasting until about June 1, when an intermission until about July 15 usually occurs, owing to the collection of a slime upon the nets. Fishing is prohibited in Ohio waters between June 15 and September 15, but the tugs make a pretence of running out of Ohio waters during the close season, and as the facts in the case are difficult to determine, the law is practically a dead letter, as far as the gill nets are concerned.

No herring are caught out of Cleveland and adjacent Ohio ports during the latter part of September and all of October, but in November they are again taken at various places, especially off Aven Point. The fishermen from Erie and Dunkirk fish continuously from July 15 until ice forms, but during the latter part of October and in November the herring are scarcer there, owing to the spawning movement of a large part of the fish toward the west end of the lake. Late in the fall, therefore, some of the tugs from Erie and other ports run to the vicinity of Huron and

Sandusky, where they are joined by the local tugs in the important fall fishery for herring, which continues throughout November and in open seasons well into the winter.

On the Canadian side the nets near Long Point catch herring from April 1 to the middle of May, when the fish run into deeper water where the small boats used by the Canadian fishermen cannot follow them, although they are caught by the tugs running out from Erie. In the same locality the fall season begins during the latter part of September and lasts until December. During November about one-half of the catch is composed of wall-eyed pike, but throughout the rest of the fall season herring are the only species caught in any numbers. The few nets used near Point Pelee Island catch herring only during the fall at the same time that they are caught on the United States side of the platform.

WHITEFISH GILL NETS.

Description.—These nets are employed solely for whitefish and trout, the mesh varying according to the species sought. For whitefish the size almost invariably used is $4\frac{1}{2}$ inches in extension, although it is claimed by the fishermen of the island region that some nets measuring 5 inches are used upon the reefs in that vicinity. The only place from which $5\frac{1}{2}$ -inch mesh is handled is Dunkirk, New York. These nets are never employed in the whitefish fishery, but only in the fall for lake trout.

The nets used by the tugs measure about 40 rods long, but in the island region the general length appears to be 12 to 15 rods each. When set they are said to hang from 4 or 5 feet deep. In the eastern end of the lake leads are used, but on the rocky bottoms at the western end rings have been substituted in order to prevent the chafing of the foot of the net.

History, quantity and distribution.—The fishery with medium mesh gill nets began about the middle of the present century (at Erie in 1852) and thus antedated by a number of years the use of the small mesh nets. The number of nets employed in this fishery appears to have gradually increased until about 1886 when the whitefish began to grow scarce and most of the Erie tugs began to use a smaller mesh for herring and blue pike. Since about 1890 a number of tugs at that place have re-entered the whitefish fishery, and in the meantime there was a development along the same lines at Dunkirk, where this fishery has received increased attention of late years.

The tug fishery for whitefish is confined to that portion of the lake east of Ashtabula, the number of vessels engaged in it in 1893, being as follows:—

			Feet.
Ashtabula,	1 tug, fishing.....		40,000
Erie	6 do		200,000
Dunkirk	5 do		200,000
Buffalo	1 do		20,000
			<hr/> 460,000

In the same year there were about 500,000 feet of netting belonging to the boat fishery, although it is doubtful if over one-half of this amount was ever in the water at one time.

The Dunkirk tugs are engaged almost exclusively in catching whitefish until about the middle of October, when most of them, if not all, begin to take trout in the $5\frac{1}{2}$ -inch mesh nets. Some of the Erie tugs mentioned are also used almost entirely in the whitefish fishery, but others, with those located at Ashtabula and Buffalo, engage to a greater or less extent in the fishery with small nets. The bulk of the fishing is done east of the Ohio-Pennsylvania boundary in depths of from 12 to 30 fathoms, and from five miles offshore to well across the lake. It is only the tugs which traverse the greater distances, the boats remaining on the grounds near the shore and thus being able to fish less continuously.

The whitefish nets are fished at all seasons in three gangs, two of which are in the water while the third is ashore darning. The gangs used by the large tugs out of Erie and Dunkirk consists of thirty-one nets, aggregating $4\frac{1}{2}$ to 5 miles each. The boats employ the same number of gangs, but there are only about one-half the length of those fished by the tugs.

Between Ashtabula and the platform there is no whitefish gill netting of importance. On the platform there are no tugs engaged in this fishery, but gill nets fished from boats are owned in the following places:—

	Men.	Nets.
Bass Islands.....	15	820
Kelley's Island.....	7	140
Port Clinton.....	6	320
Ottawa City.....	1	20
West Sister Island.....	2	40
Total.....	31	1,340

A few men from Vermillion also fish at North Bass Island, but it is safe to say that upon the entire platform there are not over 1,500 nets, measuring not more than 500,000 feet. This netting is used only during November, the spawning season. The nets appear to be nearly all in the water throughout the fishing season, and are always fished near the shore and in comparatively shallow water.

There is practically no large mesh gill netting fished on the Canadian side of the lake, although a few short lengths may be used occasionally.

Seasons and catch.—At the eastern end of the lake, the fishing begins about the middle of April and continues until the middle or latter part of December. August and September appear to be the best months of the year and the spring is rather better than the late fall. During June and more or less of July, the fishing seems to be indifferent, the reason given being that a vegetable slime collects at that time, probably influencing the fish to rise from the bottom, besides soiling the nets and causing their rapid destruction.

Early in the season the catch is largest to the eastward of Dunkirk, but in summer the tugs find the best fishing in the deeper parts of the lake, farther from land than the sailboats can venture with safety. During October and November the eastern fishery for whitefish falls off owing, no doubt, to the withdrawal of a large portion of the fish to the western end of the lake for the purpose of spawning. This diminution appears to be felt somewhat less at Dunkirk than elsewhere, owing to the presence of a limited spawning ground in that vicinity.

Throughout the entire season sketched above certain other species are caught with whitefish, the most important being wall-eyed pike of large size, the catch of these often amounting to from 10 to 15 per cent of the whitefish taken. Herring of various sizes are also caught, principally by the teeth, and, especially in the deep water in the summer, the worthless ling often causes the fishermen considerable annoyance.

During October the lake trout begin to move from the deep water to the rocky bottom between Dunkirk and Westfield, and in November and December heavy catches are made at that place in the $5\frac{1}{2}$ -inch mesh nets. This fishery is followed principally by Dunkirk fishermen who find it profitable during the last two months of the year. Formerly the Erie tugs monopolized this fishery, but since 1890 they have engaged in it only occasionally.

At the western end of the lake, the gill net fishery for whitefish is confined to November when the species come to spawn on the reefs and rocky bottom in the platform region. It is engaged in mainly by vine culturists and farmers, together with a few pound netters who may not be otherwise employed. It is carried on in shallow water, usually less than 20 feet deep, and continues about three weeks, generally between November 3rd and 28th. The whitefish taken are all large and spawning, and no other species appear to be associated with them in the nets.

Carp netting.—Within a few years the use of gill nets for taking the German carp has sprung up at several places along the south shore west of Sandusky. The size of the mesh is the same as the trout nets, namely, $5\frac{1}{2}$ inches. The total amount employed in 1893 probably did not exceed 50,000 feet.

STURGEON GILL NETS.

The sturgeon gill nets are made of relatively stout twine and the mesh measures from $11\frac{1}{2}$ to 13 inches in extension. They are about 6 feet deep, are set at the bottom not far from shore, and are tended by means of sail boats or row boats. The date of their introduction in Lake Erie has not been learned. Sturgeon fishing by this means appears to be confined to that portion of the lake lying between Irving and Buffalo, New York, where in 1893 there were 184,230 feet of this large mesh netting in use. It is employed principally by farmers, two men and 50 pounds of netting being the equipment of a boat. Until 1st May this species is caught on baited hooks, but about that date the gill nets are set and their use continues until July. They come into use again in September.

GILL NET PRACTICES.

Time out, condition of catch.—The time elapsing between the setting and lifting of the gill nets depends upon the season, the weather and the kind of fish for which they are used. The whitefish nets at the east end of the lake are allowed to remain in the water two days as a rule, and longer when Sunday or bad weather intervenes. Although unfavourable comments upon the quality of the fish so caught have been made, our observations disclosed that between 80 and 90 per cent of the whitefish landed at Erie and Dunkirk were alive when taken from the water, even after the nets had been fishing three days, and nearly all of the dead ones were firm and hard. The whitefish gill netting on the western platform is always conducted during cold weather, at which season the fish will keep longer and as the nets are set near the shore they can readily be reached at all times.

When fishing for saugers, wall-eyed pike and perch, the nets are out only one night, and, as the fish are hardy and the water cold, the entire catch is obtained in good condition. Most of the gill netting for blue pike is done at times when the water is not very warm, and, except when storms interfere, the fish are marketed in good order. At the eastern end of the lake, however, there is some complaint of the condition of the catch by the small boat gill netters during July and August.

The most serious charges in this respect relate to the herring gill net fishery, especially during the summer months. In warm weather the herring nets are left out only one day, but when the weather becomes cooler they are usually left out two or more days. It is generally agreed that the herring is the most tender fish caught in the gill nets and that they die and decompose very quickly. Observations made at several of the fishing ports and in the markets of Philadelphia and Pittsburgh showed that, while many of the gill net fish are in good condition, a considerable proportion were decidedly inferior to those taken in the pound nets. At Erie in August only one-third of the fish were in condition for immediate shipment in fresh condition. The balance were either salted or dressed before shipping. These fish were not spoiled, but merely soft and pallid and generally inferior to those considered as being of first quality. When dressed fish are received at the markets the cut edges are dark and the flesh is so soft that the bones protrude. There is no doubt that during colder weather the general condition of the gill net fish is superior to that described, but taken as a whole the gill net catch of herring is inferior in quality to that of the pounds.

Relations of mesh to size of fish.—The gill nets do not take nearly as large a proportion of young fish as do the pound nets. The mesh used for any species is supposed to be adapted to the size of fish suited to the markets. The principal dif-

floutly which arises in this connection is the capture of the young of the larger species in the nets intended for the adults of the smaller kinds. There is no complaint concerning the size of the herring and saugers, although small sizes of herring, and also of other species to some extent, often become entangled by the teeth. Many undersized wall-eyed pike, however, are taken in the small meshed nets.

In the case of the whitefish it is alleged that considerable quantities of the young are caught in the nets used for herring off Erie, Pa. This statement appears to be a reasonable one, but somewhat extended observations made during the summer and fall of 1894 did not confirm it.

TRAP NETS AND FYKE NETS.

History, number and distribution.—Fyke nets have been used in Lake Erie for a number of years, but the submerged trap net has been introduced during the last decade. Of the latter there were practically none in 1885, and the number in 1890 is not known, but in the spring of 1894 there were 152 in use. Considering the two forms of apparatus together, we find that there is a heavy decrease since 1895, a fact made evident by the following table:—

	1885.	1890.	1893.
Fyke and "Bay pounds".....	1,169	1,175	736
Submerged trap nets.....			152
	1,169	1,175	888

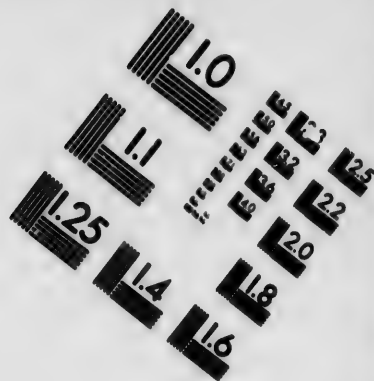
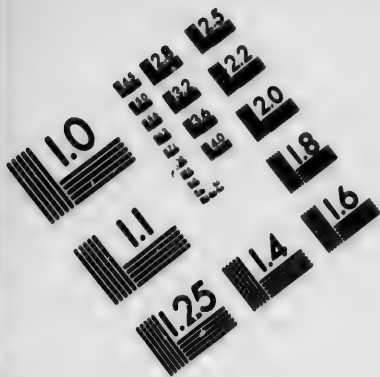
The fyke nets are all west of Vermillion, while the trap nets are all east of Loran, the two being, therefore, separated geographically although serving practically the same purpose in the fisheries of their respective regions. Sandusky Bay is the centre of the fyke net fishery, about 600 of the 736 recorded in 1893 being within twenty miles of that place, while the balance were scattered along the shore between Vermillion and Pointe Moullée, Mich. Most of the trap nets are near Avon Point, between Euclid River and Salt Creek, Ohio, and in Pennsylvania and New York. Both forms of apparatus are employed in shallow water, the fykes being used principally in the marshes and bays as well as in the open lake.

No traps or fykes are licensed or permitted on the Canadian side of the lake.

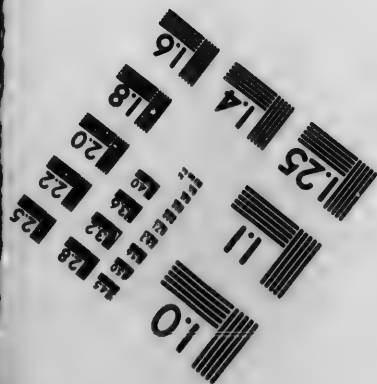
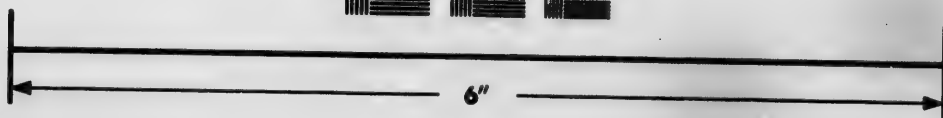
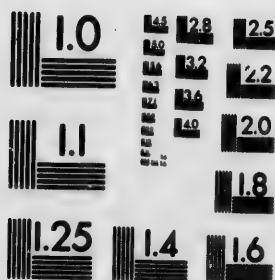
Description.—Both traps and fykes resemble the pounds in general principle through differing from them and from each other in the details of construction. The fyke net usually has a leader like a pound net, but is sometimes provided with wings instead; in lieu of a single tunnel there are often several, and instead of a square crib open at the top it has a cylindrical bowl supported on hoops and entirely submerged. Its advantage is that it is cheaper and may be handled by a smaller crew.

The trap net is essentially a small pound net with a covered or inclosed crib. Its several parts, leader, heart, tunnel and crib, are all connected and the entire structure is supported and held in place by anchors, floats and stretchers instead of by stakes driven in the bottom. Its advantages are its cheapness and the fact that it may readily be moved from place to place as the exigencies of the fishery may require. Considering its size and cost it is the most efficient piece of fixed or semi-fixed apparatus yet devised, it may be fished on any bottom and its rapid increase is to be expected.





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In the fyke nets the leaders vary from 10 to 30 rods in length and have a mesh of 5 or 6 inches. In the hearts and tunnels the mesh is from 3 to 5 inches and in the cribs a portion is always as small as 2 inches. The leads of the traps are from 6 to 10 rods long and the size of the mesh in the several parts is in general similar to that found in the fykes.

Seasons and catch.—Both traps and fykes are fished much more extensively in the spring than in the fall, owing to the greater abundance of fish at the former season in the shoal waters. With the exception of a few fykes in Michigan and some trap nets in Pennsylvania, there is no summer fishing and no fykes are fished in winter excepting a few in the marshes along the Michigan shore.

In the spring and fall the catch resembles that made by the neighbouring pound nets; although there is a larger proportion of inferior fish and an almost total absence of sturgeon, whitefish and herring. The former are lacking because they are too large to enter the nets, and the latter because they rarely occur where most of the traps and fykes are fished. Trap nets are accused of catching large numbers of black bass, both large and small, and in proportion to their size they may be more destructive than the pounds. In Sandusky Bay and Portage River, and perhaps elsewhere, the fykes catch large quantities of young catfish, but with regard to other valuable species they take proportionately no more young than do the pounds.

Lake St. Clair.—The traps and fykes of Lake St. Clair are all north of Point Huron, in the shallow waters of Anchor Bay. In general, they resemble those used in Lake Erie, although some of them present minor differences. In the fall of 1893 there were 100 of these nets and in the following spring there were 83. Owing to legal restrictions there had been a decrease of 50 per cent since 1885 and of 32 per cent since 1890. The fishery is practically confined to the spring and fall, being more important at the latter season. Named in the order of their importance the species caught are perch, wall-eyed pike, catfish, mullet, red horse, black bass, and a few others.

SEINES.

History, number and distribution.—The first seine in the region bordering upon Lake Erie was used in Maumee Bay about 1815; others were employed on the Michigan shore, in Sandusky Bay and in other places about the same time. For many years this form of apparatus was used in the bays and rivers exclusively, no effort being made to fish them in the broader waters of the lake until 1850 to 1854, when the great abundance of the whitefish began to be recognized. Subsequently the pounds were found to be better adapted to the requirements of the open lake, and since 1865 the use of seines has again been mainly confined to the more inclosed and shallower waters. In 1893 the principal places where seines were employed were on the Michigan shore, in Maumee Bay, Maumee River, Portage River and Sandusky Bay.

The fishery is of insignificant proportions compared with that by fixed apparatus and gill nets, the number of seines on the United States side of the lake having been 71 in 1885, 44 in 1890 and 47 in 1893. The principal reduction since 1885 has occurred in Ohio west of Vermillion and in New York. Since 1882 the total length of the seines on the Canadian side has never exceeded 8,500 fathoms, and in 1894 there were only 6,200 fathoms.

Description.—In Michigan the seines are 12 to 50 rods long, on the Maumee River from 40 to 70 rods, on the Portage River from 20 to 45 rods, while in Sandusky Bay some of them are 120 rods in length. The 20-rod seines are about 8 feet deep in the bunt and 4 feet in the wings, and those 70 rods long are 15 feet in the bunt and 8 feet in the wings; the other lengths have somewhat proportionate dimensions. The mesh in the bag measures sometimes 3, but usually 2½ inches, a large size is used in the wings, with the object of reducing the weight and cost and of permitting the escape of some of the small fish.

Seasons and catch.—On the Michigan shore the seines are fished principally in winter, summer and fall. In the former season the fishery is confined to the marshes, the catch consisting of bullheads and perch. In the spring and summer the smaller seines are used in the mouths of small bays and creeks, catching carp, catfish, red horse and wall-eyed pike.

From 1st March to 10th April, and in the fall there are about 20 seines fished on the Maumee River between Toledo and the rapids. In the spring they take wall-eyed pike, catfish and red horse, together with a few black bass and grass pike, and often considerable quantities of worthless sheep-head and moon-eyes. When there is an appreciable current in the river the wall-eyed pike run is often large, this species coming up the river to spawn. At Port Clinton, carp are obtained during the spring, and catfish during August. The catch in Sandusky Bay is similar to that made on the Maumee River and many young catfish and less valuable species are taken.

On the Canadian side the seines are hauled close to shore. They are employed only in the spring before the pounds are set and when the scarcity of fresh fish creates a demand for the inferior grades. The catch usually consists of suckers, mullet, bullheads and a few grass pike.

Lake and River St. Clair and Detroit River.—In the River St. Clair there are about five nets fished from May until about August 10. The principal fish obtained is the wall-eyed pike, and complaint is made that these are generally of small size. Black bass and several other species are taken in limited numbers.

In Lake St. Clair most of the seines are north of Port Huron, where they are fished in the spring and fall and to a small extent in winter. The species caught in the spring and fall are perch, which is the most abundant species, wall-eyed pike, catfish, mullet, red horse, carp, black bass, white bass, sunfish and a very few herring. In winter wall-eyed pike, perch and black bass are the principal species, the latter being sometimes taken in such quantities as to suggest its possible extermination.

On the Detroit River there is one sturgeon seine, 55 fathoms long, with a 4-inch mesh. It is fished from about May 12 to June 14, and in 1894 secured 225 sturgeon. The Michigan and Canadian fish culturists use seines for the capture of spawning whitefish, and certain farmers and others catch a few coarse fish by this means for their own use.

HOOKS AND LINES.

The hook and line fishery of Lake Erie may be classified under four heads, namely: winter fishing through the ice; spring and summer set-line fishery for catfish; line fishery for sturgeon; sport fishing.

Winter Fishery.—This is most important in the vicinity of Buffalo, where from 500 to 1,000 men are said to engage in it. These men have mostly other occupations than fishing during the remainder of the year. Each fisherman uses several lines connected with a tell-tale device, called a "tip-up," which gives notice when a fish is caught. The fishery is carried on from the time strong ice forms until it breaks up, usually from December until the latter part of February. The season's catch varies between 500,000 and 1,000,000 pounds and consists principally of blue and yellow pike, perch and herring, with a few sturgeon.

In the island region there is a winter fishery of somewhat different character, the fishermen using hand lines and being protected by canvas huts placed on runners. The catch amounts to several hundred thousand pounds yearly, and consists principally of saugers and perch, although wall-eyed pike and herring are also taken.

Winter fishing is also carried on upon a small scale at several other places, as at Erie, Pa., and Port Colborne, Ont.

Set-lines for catfish.—This fishery is declining. In 1890 it yielded 40 per cent, but in 1893 only 10 per cent, of the value of the line fisheries. The decrease was universal, and was due to the rapidly decreasing abundance of the catfish. This fishery was followed on all parts of the United States shore, but has never been considerable on the Canadian side of the lake. The length of line varies, the average number of hooks used by one fisherman being between 800 and 1,500. Two species of catfish are caught, the silver or spotted cat (*Ictalurus punctatus*) and the yellow cat (*Ameiurus lacustris*), the fishermen not always distinguishing between them.

Line fisheries for sturgeon.—The line fishery for sturgeon is confined to that portion of the lake lying within the state of New York, where it begins as soon as the ice leaves and continues until some time in June, although many abandon it for the gill net fishery about May 1. Two methods are employed—grappling and set-lines. The former can be used only when the fish are rolling upon their spawning grounds. The grapple consists of a three-pointed hook, which is dragged over the bottom and "driven home" with a jerk when it comes in contact with a fish. While this is not as destructive as the set-line grapnel used in the Detroit River, nevertheless many fish escape in a mutilated condition. The set-line fishery with baited hooks is more extensive. The lines are similar to those used for catfish but stouter, and two men fishing from a small boat use from 2,000 to 3,000 hooks. Most of those engaged in this fishery are farmers residing along shore between Irving and Buffalo. Besides sturgeon the set-lines catch other species, notably blue pike. The line fishery for sturgeon is insignificant on the Canadian shore.

Sport fishing.—The principal sport fish of Lake Erie is the black bass, including both the small-mouthed and large-mouthed species. Formerly a number of places on the lake, notably Erie, Pa., the Bass Islands, and various localities in Canada afforded famous fishing for these species. Considerable numbers of sportsmen are still attracted to the Bass Islands, but the fishing there, as elsewhere, has sadly deteriorated. The best fishing at present appears to be in the vicinity of Pelee Island and near Long Point.

Perch and wall-eyed pike are also caught for sport and occasionally a musk-nonge is taken by trawling. The perch, wall-eyed pike and bass are usually d for with live minnows, but the bass is sometimes caught on the spoon.

Lake and River St. Clair and Detroit River.—In these waters the line fisheries resemble those enumerated for Lake Erie. The principal one in the Detroit River is by means of the set-line grapnel for sturgeon. This apparatus consists of a stout line stretched across the spawning grounds and armed with naked three-pointed grappling hooks, so arranged that the sturgeon come into contact with them when "rolling." The struggling fish become caught upon one or more of these and are painfully lacerated in the attempt to free themselves. In many cases they are firmly held, but often their struggles suffice to tear them loose, usually at the expense of serious injury, and when afterwards caught in the seines they are found to be shockingly mutilated. The injuries are such that many fish must die in consequence. The method is thoroughly reprehensible.

SPEARING.

At the present time spearing is an almost unknown method of taking fish in Lake Erie, but occasionally a few wall-eyed pike are speared through the ice there, and also in Lake St. Clair and the St. Clair River. It is stated that black bass are speared on the spawning grounds in St. Clair River.

EXPLOSIVES.

No explosives are used for the capture of fish in Lake Erie, nor in the waters connecting it with Lake Huron.

SUMMARY OF CONDITIONS.

Owing to its more extensive fisheries and its exceptionally large variety of market fishes, Lake Erie presents greater difficulties in respect to the establishment of suitable protective regulations than any other of the great lakes. The subject is especially complicated by the association, generally, of several different grades and sizes of fishes on the same grounds, or the rapid replacement of one by the other, rendering it impossible to adjust the methods employed for their capture so as to insure the equitable protection of all, without imposing unjust or impracticable restrictions on the industry. The urgency for regulations other than those now in force is evidenced by the continued decrease in abundance of practically all the important varieties, while the discord produced by the five separate and wholly dissimilar codes, of laws which apply to this region, emphasizes the necessity for some unity of action. In order to treat the subject satisfactorily, however, and to insure the accomplishment of the best results, it must be divested of all unimportant elements and attention directed mainly to its more essential features.

The bulk of the catch consists of relatively few species, over 80 per cent in value of the total output for 1893 having been composed of the following forms, arranged in the order of their importance, namely, herring, wall-eyed pike, including the blue pike, whitefish and saugers. The yellow perch, sturgeon and catfishes follow next. The perch is but little esteemed; the sturgeon was once an important product, but the supply has been much depleted, and the catfishes are, for the most part, of rather local interest. Of some of the inferior kinds, such as the suckers, sheepshead, &c., large quantities are often taken, but the low price received for them and the fact that a considerable proportion of the catch may be rejected, makes them of relatively little consequence. There are also several species which are obtained only in small amounts. The black bass is the principal sport fish, but angling is also carried on to some extent for the yellow perch, wall-eyed pike and other species. The maskinonge, however, is rarely taken in the lake.

The greater fisheries of Lake Erie are, therefore, prosecuted for the herring, whitefish and pike-perches. Of the remaining species, the bulk is obtained as incidental features of the main catch, although it is not intended to imply that their capture is generally otherwise than desirable and profitable for the fishermen. Some of them, moreover, are the objects of local and special fisheries, this being especially the case with the sturgeon. The majority of the fishermen would be satisfied to confine their attention to the five forms first mentioned, or even chiefly to the whitefish and herring, provided their abundance could be maintained on a sufficient basis to insure a continuity of good catches. In our opinion, therefore, these are the species which demand the principal consideration, and, wherever necessary, the remainder should be subordinated to them. Any restrictions made in the interest of the former, however, may also be expected to benefit the latter in greater or less degree, but in some directions special regulations are desirable and can readily be provided.

The protection of the sport fishes, as represented by the black bass, presents unusual difficulties. This species is taken in the nets in company with the commercial fishes, and while commanding the highest market price, the small numbers obtained render it of no particular value to the fishermen, who would be satisfied to forgo its capture if it could be done conveniently, but no practical method of accomplishing that result has been suggested. Its rigid protection would involve restrictions, the carrying out of which would greatly interfere with the handling of the nets, and we are confident that strict compliance with such measures could never be exacted.

The whitefish occupies the first rank among the market fishes, and during all the earlier period of the fishery was its most conspicuous feature. It is still the species most highly prized by the fishermen, although it has fallen to seventh place in the extent, and to third place in the value of the catch. Its decrease is said to have been the primary cause of bringing the herring, a relative but much inferior form, into prominence, and for a number of years the latter species has been first in

both the extent and value of the entire lake output. The large size of the Lake Erie herring, its abundance in localities favourable for its capture at most times of the year, and the proximity of the grounds to important markets, have given it an advantage over the herring of other lakes and have stimulated the fishery for it to an unusual extent. Its preservation is, therefore, of more concern at present than that of any other species. The catch of yellow pike and blue pike, which are classed as varieties of the same species, the wall-eyed pike, is second only and not much inferior, to that of the herring, the blue pike being more abundant. The sauger, which is also one of the pike-perches, ranks fourth in the value of the catch. It is, to a large extent, the object of a special fishery in the early spring, when its value is greatly enhanced by the scarcity of fresh fish at that season.

Lake Erie is practically one continuous fishing ground, accessible and more or less lucrative to the fishermen in all parts. Such moderately deep water as occurs near its eastern end provides suitable conditions for certain of the more important species during the extremes of temperature, and from this area they spread out during the intervening periods, but most extensively at their spawning times. The shallow water or platform at the western end constitutes, with its surroundings, a grand spawning ground, to which a number of the species resort and on which they are captured during the breeding season, as well as during their passage to and from. In the shoal water, especially on the platform but also along the south shore, the high summer temperature drives most fishes away and causes the rotting of the nets, making fishing there unprofitable for several months. On the north shore, however, the water remains cooler during the summer, and fishing may unusually be carried on continuously during that season. The general gill net fishing is least interrupted by seasonal changes.

The character and distribution of the apparatus is determined in part by the physical conditions and in part by the movements of the fishes which they are designed to capture. Pound nets are the predominant feature of the platform and of the shallow water adjacent to it on the south shore. Introduced there over forty years ago, they have increased to an extent unparalleled in any other section of the country. Farther east on the south shore they are employed as far as New York State, but much less commonly, and many are rarely fished together in the same locality. Along the Canadian shore they are distributed rather evenly, but the number there is not one-sixth that in United States waters.

The principal gill net region is the body of the lake eastward of the platform. The longest season is furnished by the deeper waters, mainly off Pennsylvania and New York, but this branch of fishing is extended at times to most other parts of the lake, including the western platform, where, however, it cannot successfully compete with the pound nets except during the height of the run of certain species. Trap nets are used to some extent on the shores of Pennsylvania and eastern Ohio, and fyke nets to the westward of Vermillion. Seines are employed in some places, but they have been generally superseded by other methods, and are now important in only a few localities. The hook and line fishery is chiefly confined to the eastern and western ends of the lake, and is conducted on a relatively moderate scale.

On the Canadian side the market fishery is now practically restricted to the use of pound nets and gill nets, and is much inferior in importance to that in United States waters. The shore is not adapted to such extensive strings of pounds, and the gill net fishery is carried on solely by means of small boats.

The extent of the decrease among even the more important fishes cannot generally be determined specifically from the information which is available, but in some cases it has been so marked that its magnitude can readily be estimated. The causes of decrease are still more difficult to fix in detail, but the principal influences concerned therewith may be inferred with a reasonable assurance of reliability.

The early fisheries in Lake Erie were prosecuted almost exclusively for the whitefish, but at that period it was only taken close inshore and mainly, if not entirely, during its spawning run. After a time, however, the means of capture were rapidly multiplied, and the species was followed to its most distant grounds. During the warmer and colder months it inhabits chiefly the deeper waters in the

eastern part of the lake, where an extensive gill net fishery has long been established, and where, for some years, by far the greater part of the market supplies was obtained. In the spring and fall its migratory instinct causes it to seek the shallow waters along both shores and at the western end, in all of which situations it is taken by the pound nets in large quantities. During the fall or spawning movement it reaches certain reefs on the platform, and there provides the opportunity for a special gill net fishery of short duration.

The statistics show a falling off in the annual output of the whitefish in United States waters during the past ten years amounting to over 60 per cent. This decrease has been greatest in the gill net region at the east; next extensive in the western or pound net region, and least pronounced in the intermediate district where the smallest catches have been made. In Canadian waters, where it is taken almost exclusively in pound nets, the decrease has been almost, if not equally, as great as on the south shore; and Lake St. Clair has felt the depletion in like degree, as its supplies are derived from Lake Erie.

The decrease on the south shore undoubtedly began sometime before it was brought out by the statistical inquiries; on the north shore it was manifested by the pound net catch as early as 1874. It is said, however, to have been first severely felt at the eastern end of the lake, where the fishery seems to have reached its maximum development about, or shortly before, 1885. Owing to the extent of the depletion at that time, most of the gill net fishermen abandoned the pursuit of this species and turned their attention to the herring, but the fishery has again increased, and appears to be carried on once more upon as large a scale as the supply will warrant. The pound net fishery at the western end attained its maximum development about 1890, its later growth at least being characterized by a continuous decrease in the whitefish catch.

The depletion has unquestionably been the result of overfishing by both the pounds and gill nets, no other form of apparatus having figured prominently in connection with this species in recent years. Too many nets have been employed, and too large a quantity of the adult fish has been removed from year to year. In the deeper waters constituting the normal habitat of the species, the fishery by gill nets was persistently carried on upon a most extensive scale, and without restrictions, during practically the entire open season of each year. The fish are there confined within a comparatively limited area, under most favourable conditions for their capture. It was there that the largest catches were made, and a study of all the evidence presented tends to confirm the assumption that the greater part of the decrease actually took place in that region, with which it has also been identified by the statistical returns. The arrangement of the pound nets is with reference to the shoreward and westward movement of the species in the spring and fall. These appliances extend across the pathway of the fish at such frequent intervals, and intercept their passage so extensively by whatever course they take, that it is almost surprising any should reach their spawning grounds. On the reefs, moreover, while depositing their eggs, they are again the objects of a gill net fishery, and the schools which enter the Detroit River and Lake St. Clair have been decimated by the seines and pound nets.

In the earlier days the gill net mesh was larger than it is at present, and the reduction in its size was made in order to adapt it to the smaller average size of the fish, the larger sizes having, apparently, been more generally caught off. This modification of the mesh must certainly be regarded as indicative of a certain amount of decrease in the abundance of the fish, and its adoption shows that the tendency to push the fishery beyond a proper limitation had its beginning many years ago. We have failed to secure satisfactory proof, however, that the decrease has been materially aided by the capture of the actually young or undersized fish, as has occurred with some of the other species. Very few young whitefish are ever seen on the platform or elsewhere in the pound net region at the west end. It is reported that many fish of that character are taken in some of the more eastern pound nets and also in the herring gill nets when employed in the deeper waters. That such may be the case is not improbable, but the subject requires further investigation before the evidence presented to that effect can properly be weighed.

To what extent the pollution of the water may have influenced the decrease of this species it is impossible to say, but at the most it can not have ranked as a very potent factor in comparison with the fishing practices above referred to.

Many of the fishermen are confident that in recent years the decrease of whitefish has been checked through the agency of the hatcheries, but their statements in that regard are not sustained by the statistical returns. It is probable, however, that except for the assistance of artificial propagation the amount of decrease would have been much greater.

The herring did not become an important object of the fisheries until a very much later date than the whitefish, but with the decrease of the latter it has attained the principal position in the lake catch. This species has essentially the same distribution and movements as the whitefish. It lives in the deeper waters during the greater part of the year, but appears to occupy there a wider area, and even during the extremes of temperature may be found in small numbers on the western platform. Its spring and fall migrations are practically identical in character and extent, and its spawning season does not differ materially from that of its larger relative. The platform contains important, if not its principal, spawning grounds, although there is every reason to suppose that the species also spawns extensively further east, but in what locality has never been determined.

The fishery for the herring is conducted by the same methods as for the whitefish, and upon the same basis, but it long ago reached a much greater magnitude, due in part to the greater abundance of this form and in part to the increased demand for the products of this lake. The pound and gill nets are the principal appliances by which it is captured, but, unlike the whitefish, the larger part of the catch was until recently obtained in the western part of the lake through the agency of the pound nets.

The maximum catch indicated by the statistics for United States waters was made in 1890. In 1893 the total quantity obtained was nearly 50 per cent less, although the amount of gill netting in use was much greater, and the reduction in the number of pound nets had been comparatively small. In the latter year the catch was largest in the eastern part of the lake, smallest in the western part, and between the two in the intervening region. In the eastern district the catch was somewhat smaller in 1893 than 1890, but not sufficiently to be indicative of an actual reduction in the supply except for the great increase in the extent of fishing. The bulk of the decrease had taken place on the platform and in the closely adjacent region, although a heavy falling off was also manifested along the central part of the coast. The pound net catch was the only one which suffered at the west, the gill nets having been even more successful than in 1890.

In looking for the cause of decrease in the western catch, we find that during several years prior to 1890 this species was being taken by the pound nets in certain places in somewhat reduced numbers. Then came an abrupt and very pronounced falling off, which was first manifested at Port Clinton in 1890, at Huron and Vermillion in 1891, and about the Bass Islands, and Kolley's Island in 1892. This sudden drop occurred immediately after the extension to the platform region of the heavy gill net fishery which had previously been confined to the deeper waters. The tugs belonging at eastern ports had started the practice of following up the schools of herring during their fall or spawning movement, and, deriving great profit in that connection, they were joined by the local tugs in operating both on the surface of the platform and adjacent to its eastern border. While the evidence clearly indicates that the pound net fishing had previously been excessive in respect to this species, we cannot doubt that the final change was the direct result of the recent gill net methods.

It has been impossible from the information obtainable to determine in precisely what manner this condition was brought about. The statistics do not favour the view that the decrease has been produced simply or solely by the taking out of too many fish. The prevailing opinion among the fishermen is to the effect that the course of the schools has been diverted by the many nets, which prevent their reaching the surface of the platform except in relatively small numbers, and causes

them to occupy other than their customary grounds in the late fall. It is said that large bodies have been seen spawning in recent years off the south shore between Huron and Fairport, where such an occurrence was previously unknown, but the statements in that regard lack confirmation. A very reasonable deduction is that, being prevented from reaching their proper spawning grounds, their eggs are largely deposited in situations not suitable for that purpose, with the result that the productivity of the species has been much impaired.

The Canadian statistics, which are taken annually, show a comparatively uniform catch of herring along the north shore since 1885, coincident, however, with a very large increase in the amount of apparatus, both pound nets and gill nets, by which they are taken.

There is no evidence of the destruction of an appreciable quantity of the young herring, which seem never to be present in the pound net regions except in small numbers, and in the deeper waters would escape capture in the gill nets, except as they occasionally become entangled in the twine. Overfishing and the practices before described, so far as can now be determined, must be held accountable for practically the entire decrease which has been observed.

The wall-eyed pike, represented by its nominal varieties, the yellow pike and blue pike of the fishermen, follows next after the herring in the extent and value of the catch in Lake Erie. The yellow pike is supposed to belong more especially to the western shallow waters, and the blue pike to the deeper areas and the main body of the lake. There is evidence of a considerable decrease in the abundance of this species, which has been felt to a greater or less extent in the different fishing regions, but temporary local increases are sometimes noticed, which occasion doubt in the minds of some fishermen as to whether any change in the status of the supply has taken place. The pike has suffered less in this respect, however, than either the whitefish or the herring, notwithstanding that it is the object of a much more diverse fishery, being secured by practically every method which is here employed. The bulk of the catch, as with the species named, is obtained in the gill nets and in the pound and trap nets. The decrease has undoubtedly been due to overfishing, combined with the excessive capture of undersized fish, of which it is estimated that many hundred tons are taken and disposed of every year. The gill nets secure a larger average size than the pounds and other fixed appliances, and have, therefore, been less detrimental in this respect. No practical remedy can be suggested with regard to the latter means of capture, which are supposed to be adapted mainly to the herring and must necessarily be so constructed as to prevent the meshing of that species. A large proportion of the catch of the pike-perches is taken in connection with their spawning run in the early spring.

The policy of affording any measure of protection to the wall-eyed pike and its related species the sauger, has been strongly deprecated by many fishermen because of their well-known predaceous habits, and it is even claimed that the catching off of these forms in Lake Erie has produced an increase in the supply of herring. There is no ground for the latter belief, and no evidence that the herring were ever less abundant than at the period of their maximum catch a few years ago, as before explained. The statistics, moreover, credit the herring with a greater decrease than is apparent among the pike-perches.

The removal of any fish of supposed pernicious influence from so complex a fauna as that inhabiting Lake Erie, in view of our present imperfect knowledge of the conditions there existing, would at least be impolitic, and we cannot regard with favour the proposition, so often advocated, that every opportunity should be afforded to rid the lake of the fish-eating species. In a much smaller body of water it may at times be possible to adjust the balance of nature by artificial selection. In Lake Erie or in any other similar body, such a task would be fruitless, and any considerable change produced might cause more harm than good. The number of so-called predaceous species is quite large, and the inter-relations of these are such that we must expect the one to act as more or less a check upon the other. By removing one or any group of such species we may unwittingly provide for a more vigorous onslaught on the herring and young whitefish. The extensive fisheries which

have now been carried on for so long a period have undoubtedly tended to disturb the balance of nature originally prevailing in this lake. There is no way of preventing such an occurrence or of determining what the final outcome may be, but with the light we now possess on the subject, we consider it unwarranted to deliberately sacrifice any species which occupies an important position in the fisheries or may continue to be a source of profit to the fishermen.

The saugers, which come next after the wall-eyed pike in the size of catch, occur most abundantly along the south shore west of Vermillion and about the islands on the platform, where they are the object of a special gill net fishery in the early spring, and continue to be taken later by the pound nets. The statistics show no material decrease in the output in recent years, but a large increase in the means employed for their capture. As with the wall-eyed pike, the gill nets catch the larger average size of fish, and as this species is smaller than the other, practically only the adults are secured in this manner. The pound nets, however, are very destructive of the young.

Originally one of the most common fishes of the lake, the sturgeon has suffered relatively more depletion than any other. It was formerly a very prominent feature of the pound net catch, especially before its value had been recognized and while its capture was regarded as a nuisance. The fishermen at that time destroyed it in immense quantities, and when a market had been found the supply was already much reduced. It has continued to be taken by the pound nets and has also been made the object of a special fishery by means of gill nets, hooks and lines and seines.

The species is at present most abundant at the extreme eastern end of the lake, and elsewhere more plentiful along the northern than the southern shore. The principal cause of decrease and the one which has been longest in operation has been the pound net fishery, but the statistics show a continued and heavy diminution in the supply where gill nets and hooks alone are now employed. The sturgeon is classed among predaceous fishes by many fishermen, but in what degree it merits this distinction we have been unable to decide. In the absence of more conclusive evidence as to the extent of its destructiveness, and for the reasons stated in connection with the wall-eyed pike, we regard the species as deserving of such protection as can be granted it without detriment to the more important branches of the lake fishery. Its size and hardness permit of the return to the water alive of all immature individuals which may be taken by any method, and much good can undoubtedly be accomplished by this means, as a large proportion of the pound net catch especially consists of the small fish. It is important, furthermore, that the extent of the special fisheries for the species should be materially reduced, and the gill net mesh should be so regulated in size as to prevent, so far as possible, the capture of any individuals below the generally accepted standard of four feet in length. We consider, moreover, that the use of naked hooks or grapnels on the spawning grounds is a prencious practice which should not be tolerated.

The black bass is the principal game fish of Lake Erie, and the sportsmen demand for it the fullest measure of protection. We fail to see, however, how its preservation can be provided for on a comprehensive basis, owing to its constant association with many of the market species. The commercial fishermen would be entirely satisfied to exclude it from their catch, were it possible to do so, but we find that any plan having that object in view would be entirely impracticable, for reasons which are elsewhere explained. There is no way of preventing the entrance of the bass into such appliances as the pound nets, trap nets and fyke nets, and once so taken their return to the water alive must depend upon the caprice of the fishermen, however stringent may be the regulations put in force. We would, however, urge the protection of the species during its spawning period, as well as during its younger stages or until it has attained what may be regarded as a fair size for capture. Whether such provisions would be effective or not can only be determined by experience. Special regulations may be found advisable in some localities, such as the prohibition of certain kinds of apparatus or a modification of the methods, but all such arrangements must be based upon a knowledge of the local conditions and requirements.

It is not essential to discuss the remaining fishes in this connection. A few of them, such as the catfishes, are of considerable importance, while others which are taken only in small quantities are still desirable features of the catch. In some instances special measures might be suggested for their preservation, but their protection as a whole should, in our opinion, be subordinated to that of the more abundant and important species in which the fisheries of the lake are chiefly concerned. Any steps taken in the interest of the latter will incidentally operate to their advantage, and to some extent in like degree.

The apparatus employed in the fisheries of Lake Erie, named in the order of the value of the catch by each in 1893, are gill nets, pound and trap nets, hooks and lines, fyke nets and seines. Over 85 per cent of the total output was secured through the agency of the gill nets and pounds (including the traps), which shows them to be by far the most important of the fishing methods.

Although the fishery on this lake was chiefly carried on in early times by means of seines, it received its first decided impetus through the introduction of the pounds, which is said to have taken place about 1850 or soon thereafter. The first of these nets was established at the western end, where the conditions are especially favourable for this method of fishing, and where their number in United States waters has increased in an unparalleled degree. Along the remainder of the south shore and on the Canadian shore they have been used much less extensively. The maximum number in United States waters appears to have been reached in about 1890, when it amounted to about 1,500, nearly twice the quantity fished in 1880. By 1893, however, it had fallen off to about 1,300, and a further reduction was contemplated. On the Canadian side there were 11 pounds in 1869, from which date the number increased quite steadily to 210 in 1892, decreasing to 202 the next year.

On the south shore it is the common practice to set the pounds in continuous strings, made up of a variable number of nets, extending out from the shore a greater or less distance, dependent upon the conditions existing in each locality. In some instances these strings have contained as many as 30 or more nets and have reached a length of five or six miles, and although such cases are exceptional the proportion of long strings is very great. While this method of multiplying the nets is followed to some extent elsewhere, it is carried to the greatest extreme on the western platform and in the closely adjacent region, where the expanse of shallow water is especially favourable for this purpose. Placed at right angles to the shore line, these strings constitute a rapid succession of rigid barriers to the passage of all fish working along the coast, whose movement is thereby checked or diverted, no gaps being provided except in the rare cases demanded by navigation. On the Canadian side no more than two or three pounds are ever arranged in a string, and they are generally fished singly. The individual leaders measure generally from 50 to 60 rods, but the inner ones may be much longer, according as the depth of water dictates. The mesh is usually large enough to permit the passage of small fish, but it is doubtful if much advantage is gained by this circumstance. The wall of netting changes the direction of the schools, which as a rule, turn and follow outward toward the opening into the nearest crib. It is here that every precaution is taken against escape, by reducing the mesh to the smallest dimension that can conveniently be handled, this being done chiefly to prevent the gilling of the smaller sizes of fish.

The harmfulness of the pounds is measured by their capacity for removing large quantities of many different kinds of fishes without discrimination, especially when the nets are multiplied as they have been in these waters, and their destructiveness of the younger stages. Custom has regulated the length of the leaders in conformity with what is supposed to be a safe distance over which the more important species may be expected to follow in a single line when diverted from their regular course. The effectiveness of the strings is insured by inserting the cribs at relatively short intervals. Along an abruptly sloping shore the fish may be expected to move in somewhat compact bodies, but to spread out as they reach a more gradual slope or a level surface, such as is presented by the platform. Advantage has been taken of this habit in arranging the distribution of the pound nets. Experience has taught the fishermen where the schools can most profitably be intercepted, and sharp com-

petition, unrestrained by any regulations, has led to their extension in all directions, so that it seems little less than marvelous that any considerable number of the migratory species should be able to reach their spawning grounds.

That the pound net fishery as a whole has been greatly overdone is evidenced by the fact that several years ago it ceased to be profitable on the scale on which it was and still is conducted. From the standpoint, therefore, both of the fisherman and of the objects of his industry, it requires an entire revision, but it is certain that nothing effectual can be accomplished without recourse to heroic measures. The reduction in the number of nets should be sufficient to produce a decisive result. Furthermore, only a limited number should be allowed in any one place; the length of the strings should be lessened and their continuity broken, and access by the whitefish to their spawning reefs should be interrupted to as small an extent as possible.

The capture of immense quantities of young or undersized fish by the pound nets is the most serious feature connected with their use, in view of the fact that there is no practical means of preventing it under the present conditions of the fishery. It is considered very essential that the mesh of the crib should be small enough to prevent the gilling of an appreciable quantity of the fish taken, as otherwise the net is difficult to lift and many fish are rendered unfit for market. Where only large fish occur, or where it is desired to obtain only a large grade, between which and the next grade below there is considerable difference in size, a mesh can be selected that will assort them conveniently. Such was the case in respect to the early pound net fishery on Lake Erie, when only whitefish were in demand, and when a mesh as large as 5 inches was sometimes employed. At present, however, the desirable part of the catch is largely composed of herring and pike-perches, all of which run much smaller than the whitefish, and the several species may be found more or less associated together at times in the same localities. In order to accommodate the mesh to these forms, it has been reduced mainly to between 2 and 2½ inches, but it becomes still smaller through shrinkage while in use. A larger mesh than 2½ inches, it is claimed by the fishermen, cannot be employed except to such great disadvantage as practically to prevent the profitable continuance of the fishery.

Recent experiments, conducted under our supervision, show that a 3-inch mesh will gill large quantities of adult herring, both before and during the lifting, many of which are found to be unfit for market when the net is raised; it will also allow wall-eyed pike, weighing over a pound, to pass through and escape. A 2½-inch mesh caused the gilling of fewer fish than the 3-inch mesh, but of more than in the customary size used near it in the same locality. It would undoubtedly serve to liberate a large proportion of the small pike-perches, which are the most objectionable features of the catch and which it is very desirable to preserve. Its advantages should be further tested under proper auspices, but until that has been done, we feel constrained to recommend nothing larger than a 2½-inch mesh for the cribs, but that should be the size after shrinkage and when the nets are actually in use. This would be a very decided improvement upon the present practice, and would not fail to secure the release of many small wall-eyed pike and saugers, which are now marketed at an inferior price. Young whitefish and herring do not seem to be present in appreciable quantities in the principal pound net regions.

An alternative method of preventing the destruction of undersized fish by the pound nets is to provide for their return to the water alive, as the catch is being transferred from the net to the boat. Were such a measure feasible, it would prove a fortunate solution of this vexed question, and leave the size of mesh to be settled at the convenience of the fishermen, but we consider the proposition to be entirely impracticable as regards Lake Erie or any body of water having such complex and extensive fisheries. Under all ordinary circumstances, the fish will remain alive and in good condition in the cribs for a considerable period, and were the catches uniformly small, the undesirable portions could be readily culled out, but such is generally not the case. The catches usually consist of a considerable quantity of material, and during good seasons may run constantly very large, representing

several species, some of which may have no market value. As the fish are marketed in fresh condition, and any serious delay may cause their deterioration, if not their entire loss, the important question is to secure their transfer to the nearest railroad or steamboat landing with the least possible delay. Nothing will be allowed to interfere with the accomplishment of that purpose. Were the fishermen obliged to release the small fish alive, the latter would probably not be brought to shore, but in nearly every case, especially during the height of the season, the sorting would be deferred until the contents of the several cribs visited were emptied into the boat and the homeward trip had begun. Only the most hardy fish could survive such treatment under the most favourable circumstance. The enforcement of such a regulation could not be accomplished except through the constant vigilance of a large number of wardens, and were its provisions thoroughly carried out, we are confident that the pound net fishery would in a large degree become unprofitable. We are, therefore, convinced that the sorting out of the young fish is practicable only to the extent that can be arranged for by the enlargement of the mesh. So far as this measure fails to secure the ultimate result desired, namely, the maintenance of the supply of fishes represented by the young individuals in question, the remedy is to be found in the further curtailment of fishing operations.

In respect to the releasing of fish alive, however, we make exceptions in favour of the sturgeon and the black bass; in the case of the former because it is a conspicuous and hardy species, and of the latter because of the obligations due to the sporting interests. Neither of these species is now taken abundantly in the pound nets.

The trap nets and fyke nets are objectionable from the same standpoint as the pounds, in that they are very destructive of the young fish, but the mesh is practically the same in all. Whitefish and herring are taken only by the traps and in comparatively small quantities. The latter nets have been introduced in this lake within about ten years, and are now employed only to the eastward of Lorain, Ohio, on the south shore. There were 152 in use in 1893, but possessing certain advantages, especially as to the ease with which their position may be changed, their number is likely to be much increased. The fyke nets are confined to the western part of the United States shore, and are more adapted to the inclosed waters and marshy areas, where they catch many of the inferior grades of fish besides the pike-perches, black bass, etc. The quantity of these nets employed in some places, as in Sandusky Bay, is very large, and, under such circumstances, they have been responsible for a great amount of damage.

The gill nets employed on Lake Erie are separable into three general classes, namely, a small mesh appropriate for the herring and most of the pike-perches, a medium mesh for the whitefish, and a large one for the sturgeon. The gill net fishery for sturgeon is restricted to New York waters, where it is carried on in conjunction with the use of both baited and naked hooks. That it is being prosecuted on much too large a scale is evident from the continued rapid decrease in the abundance of this species. While the releasing alive of all sturgeon caught measuring less than four feet long is recommended, it is also deemed advisable to so regulate the size of mesh in these nets as to provide, so far as possible, for the voluntary escape of the smaller fish. Observations respecting the minimum size of sturgeon taken in the present mesh, which measures from 11 to 13 inches, are lacking.

Whitefish gill netting is limited to two regions, the eastern deeper waters and the spawning reefs on the western platform. In the former, it is carried on during practically the entire open season. This area is the common resort of at least the main body of the whitefish, and the species is present there at all times, although the quantity becomes much reduced during the periods of their shoreward movement in the spring and fall. Advantage was long ago taken of this circumstance to build up the most extensive of the gill net fisheries of the lake. Having been carried to excess, with the inevitable result of causing a serious depletion of the whitefish, it was mainly abandoned about 10 years ago. The temporary relief thus afforded was undoubtedly beneficial to the species, but the fishery as again increased in magnitude, while still much smaller than at a former period, it is evidently being con-

ducted on a much larger scale than the supply will warrant. The fishery on the spawning grounds is much less extensive and of short duration, but by many it is regarded as pernicious from the fact that it decimates and disturbs the fish while they are collected together within limited areas for the purpose of carrying out their most important function. The injury which may thus be done is mitigated, to a greater or less extent by the efforts made to secure the greatest possible amount of spawn for artificial hatching, and by the planting of the fry in the same waters.

The size of the mesh in the earlier whitefish gill nets ranged from 5 to 5½ inches. It has been reduced, through the catching off of the larger run of fish, to 4½ inches. While the latter size appears to take no whitefish below a suitable market standard, yet we consider that the maintenance of the species could best be secured by a return to the original practice.

In the small special fishery which is carried on for the lake trout, a 5½ inch mesh is used. Not considering it important to provide for the preservation of this species, no modifications in the extent or manner of its capture are suggested.

With the falling off in the supply of whitefish, the small-meshed gill nets grew rapidly in favour, until now the quantity employed is much greater than that of all the other kinds combined. Although used in practically all parts of the lake, their principal field is to the eastward of the platform, mainly in the deeper waters, the catch consisting chiefly of herring and blue pike. At the west end there is a special fishery in the early spring for saugers, wall-eyed pike and perch. The eastern fishery has steadily increased in magnitude, due to the exceeding abundance of the fish in that region, and to the practically unlimited demand for the cheaper grades, which has sprung up in recent years. As elsewhere explained, the catch of herring and blue pike in this section of the lake has only been maintained by the constant expansion of the fishery, and its extent for some time past has evidently produced an excessive drain upon its resources. Within a few years, moreover, the practice has grown up among the gill net tugs of pursuing the herring during their fall movement toward and over the platform. This innovation was immediately followed by an abrupt and very serious decrease in the abundance of that species throughout the western pound net region, which we feel confident was chiefly due to that cause.

Complaints are made that the summer gill net fishery produces an inferior quality of fish, and that many herring are wasted through their rapid decay in warm weather. It is also said that a great destruction of the same species is occasioned by the loss of nets in winter, and close times covering both seasons have been suggested as a means of obviating these troubles. This subject will again be referred to.

The size of mesh in this class of gill nets ranges mostly from 3 to 3½ inches, but is sometimes as small as 2½ inches. It is regulated by law to not less than 3 inches on the Canadian side, while in United States waters the favourite size is 3½ inches. Experience indicates that the latter size is best suited to the general run of fish, especially the herring, for whose capture it is chiefly used, and we consider that no smaller should be allowed, having in view the greater protection that would thus be afforded the young wall-eyed pike and saugers.

The number of seines now employed in the Lake Erie region is very small, but in some of the localities where they are still utilized much injury may be occasioned by them, especially on and about the spawning grounds of such species as the pike-perches and the black bass. In all such places their use should be restricted or abolished, but we have heard of no serious objections to this mode of fishing under suitable limitations and with a proper size of mesh.

The hook and line fishery is of relatively slight extent, although of considerable importance in some localities. It is carried on mainly for the pike-perches, yellow perch, catfishes, etc., in connection with which no unfavourable practices or conditions have been brought to our attention. It is possible that the capture of sturgeon by means of baited hooks, in conjunction with the gill net fishery for the same species, is being conducted on too large a scale, but the facts in this case can only be determined by further observations. We deprecate the use of naked hooks or

grapnels for the sturgeon. The value of the sport fishery has greatly deteriorated in recent years, but we cannot suggest no means of securing for it any considerable measure of relief, as before explained.

We find that the principal causes of decrease among the important food fishes of Lake Erie have been excessive fishing in the case of all species, and the destruction of immense quantities of the young in respect especially to the pike-perches and the sturgeon. Relief is to be sought, first, through a reduction in the amount of fishing, and, second, by the correction of certain practices which may be regarded as pernicious. How far the extent of any fishery needs to be restricted in order to bring it within the limitations of its resources, must be decided upon an arbitrary basis until some means of measuring its capacity can be found. Up to the present time Lake Erie has never been studied with this object in view. We know, however, that the resources of all the larger fisheries on this lake have been overtaxed. Where the output has not actually diminished it has been kept up by the employment of a greater amount of apparatus, and, sooner or later, the inevitable result must follow. A decrease has been manifest in the case of all the important species, but to a greater degree with some than with others, dependent upon the length of time they have been fished for and the persistence with which they have been followed up.

The means by which all of these species have been chiefly taken are the pound nets and gill nets. One measure for their protection, and we consider it the most important one, is, therefore, a reduction in the amount of each of these appliances allowed to be fished in connection with each branch of the fishery. The pound nets must naturally be regarded as a whole, being set for whatever species may come their way. Their number is not excessive on the Canadian shore, nor generally on the eastern part of the south shore, so far as we can judge; but at the western end of the lake in United States waters their number has been multiplied beyond reason, and, in our opinion, it should be reduced at least one-half. The effect of such a change, in connection with the proposed shortening of the strings and breaking of their continuity, would undoubtedly soon be felt in an increase of the supply of fish and in greater individual prosperity among the fishermen who continue in business.

In some places the extent of the fyke net fishery also requires to be much restricted, and neither these nets nor the trap nets should be multiplied beyond a reasonable number in any part of the lake.

It is more difficult to determine what may be a safe and proper limitation for the different branches of the gill net fishery, but we think that each of them, namely for the whitefish, herring, pike-perches and sturgeon, is being carried on too extensively, and that a decided reduction is demanded, especially in the case of the whitefish, herring and sturgeon. It is questioned whether any regulation limiting the amount of gill netting can be effectively enforced, owing to the condition surrounding their employment. In the event of such a restriction being found impracticable, we would suggest that essentially the same result might be accomplished, by instituting one or more close seasons, to be so fixed as to time and duration as to offset, so far as possible, the overfishing at other periods. In this connection, however, it is important to bear in mind, that it is sometimes possible to so increase the magnitude of a fishery during the open season as practically to render ineffectual the shortening of its duration. We, therefore, consider that some restriction should be placed upon the extent of gill netting even in the event of a regulation by means of close seasons being adopted.

In case close seasons are provided for, the arrangement of their dates must occasion some trouble and give rise to much controversy. To be beneficial, they must occur at times when the fish could be taken abundantly and when to prevent their capture would accomplish some purpose. It is imperative that a sufficient number of the fish should have the opportunity of spawning to insure the perpetuation of the species. This is a leading principle in fishery regulation, and its observance is especially important in the case of those species which migrate along regular courses towards their spawning grounds. The whitefish is an example of

such a form, and we are confident that, could its protection from capture be insured during and just preceding the spawning period, a rapid increase in its abundance might be expected. Such a measure would require, however, that its capture in the pound nets at that season be also prohibited. As the whitefish composes only a small proportion of the pound net catch, and its release alive from those nets can not be accomplished, the fall season of the pounds would need to be greatly shortened, in which event their use at that time of year would become unprofitable in many cases. The question of expediency, therefore, arises in this connection, and, while we are confident that the fall close season is a proper and justifiable measure in regard to this species, we request for it a more thorough study of the conditions than we have been able to make. It would be most advisable to commence such a season in time to give the whitefish right of way during the greater part of the period of its western movement. Something, however, might be accomplished by a close season of even limited duration while spawning was in progress; and the prohibition of all fishing on and about the reefs would be of material benefit—provided, however, that fish cultural operations do not compensate for the losses otherwise made. Whatever may be done at the western end of the lake, however, it seems important that a restriction should be placed upon the extent of whitefish gill netting at the east end.

While the herring is similar in its habits to the whitefish, it presents sufficient differences to suggest another line of treatment. Its spawning grounds appear to be more widely distributed, not only on the platform but elsewhere as well, and its principal decrease seems to be traceable to a more definite cause. We see no objection to a fishery for the species during the fall by means of pound nets, restricted in the manner before proposed, and also by gill nets, but we consider the extensive use of gill nets on the platform at that season as exceedingly harmful and would urge its prohibition. If the gill net fishery for the herring is to be restricted by the establishment of a close season, we feel that the latter would be most justifiable at the time of year when the greatest waste of fish occurs, namely, the summer. At that season many herrings are undoubtedly destroyed in consequence of the high temperature, and a large proportion reach the market in poor condition. A loss is also said to occur in the winter through the destruction of the nets by storms and ice, but the fishery is then comparatively limited in extent, and less would be gained by stopping it. Many prominent fishermen have proposed a winter close season for both the pounds and gill nets, beginning November 10 or 15, which could not fail to insure some benefits to both the herring and whitefish.

We have been lead not to suggest a close season for the wall-eyed pike, except as they may be taken in the fisheries for the whitefish and herring, but we feel that so far as possible they should not be molested on their important spawning grounds.

As before explained, we deem it impracticable to attempt the protection of the young fish in general by releasing them from the nets, but we urge that their capture be guarded against to the fullest extent by a proper regulation of the size of mesh.

It has been and still is the common practice to throw overboard at once, while the net is being lifted or during the trip in, the rejected dead or undersized fishes, so far as that can be done conveniently. With large catches, these undesirable portions may be brought ashore and after culling carried out and dumped in the lake, unless some other means of disposing of them are found. The offal is also treated in the same manner, although the greater part of the fish are dressed on land. The quantity of refuse of this character which finds its way into the waters of the lake must be considerable, and while there is a difference of opinion regarding its effect, we believe that the practice must be more or less detrimental to the fishing interests. It is now prohibited on the Canadian side. Large quantities of city garbage are also dumped in the lake. We have not been able to ascertain what influence other kinds of pollution may exert in the lake proper, but some of its tributary streams and bays have been seriously affected by the drainage from large communities and manufacturing establishments situated thereon, and especially by the overflow of petroleum and of the waste products derived from the use of this oil. The spawning grounds of the pike-perches and of other species have apparently been greatly

damaged in some localities by this cause. The dumping of dredged materials in connection with harbour improvements is said to have injured some of inshore fishing grounds, and the deterioration of the fisheries in the Detroit River has been partly charged against the heavy traffic which passes that way. The drainage of marsh lands has caused the extensive dying out in some places of grass pike, the large mouthed black bass and bull heads.

While no positive evidence of the success of fish culture on Lake Erie has been adduced, owing to the fact that the whitefish fry there planted represent the same variety which naturally inhabits the lake, we are confident that the supply of that species has been materially benefited thereby. As the advantages to be gained by this means must be measured by the quantity of young fish returned to the water, and as the stock of whitefish has been so greatly depleted, we strongly urge that the scope of the operations in this direction be increased to the fullest extent possible. We do not recognize the present need of propagating other species than the whitefish, unless it be the wall-eyed pike, which has already received some attention in that respect.

The pound net is the only form of fishing apparatus which might interfere with navigation in this lake, and it is not in the nature of a serious obstruction. Vessels may run across the leader of the net, which constitutes its major part, with little danger of sustaining injury, but the stakes, especially in dismantled pounds and when broken of just below the surface, have occasionally given trouble. The nets of this class are nowhere set in the course of through navigation on Lake Erie, but they do stand more or less in the way of vessels passing between most points on the south shore at the west end.

The proposed reduction in the number of pounds and in the length of the strings, together with the separation of the individual nets in the latter by broad gaps, will materially relieve the annoyance now resulting from this cause. It is desirable however, that the positions of passageways between nets be marked at night by means of lanterns in all places where they are likely to be much used. This course is now followed in some localities. All stakes should be entirely removed from the water at the close of the fishing seasons.

RECOMMENDATIONS.

Pound nets.—It is imperative that the extent of the pound net fishery, especially in the western part of the lake, be very materially reduced, and that the positions and distance apart of these nets be so regulated as to make ample provision for the free circulation of the several important fishes. Although further observations will be necessary before the limitations of so comprehensive a measure can be properly adjusted or its details perfected, we venture to offer the following suggestions respecting it:—

That the total number of pound nets in the lake be limited to 1,000. The reduction in the number is intended to apply mainly to the United States waters from Vermillion westward.

That the number of such nets set in a string be restricted to 6 on the United States shore, and to 3 on the Canadian shore.

That the length of the pound net leaders be restricted to 50 rods.

That in all strings the individual pound nets be separated by gaps between each crib and the next succeeding leader, which gaps shall be at least 50 feet wide and shall extend to the bottom.

That all pound nets or pound net strings be separated laterally by interspaces of at least one mile.

That no pound nets or strings of pound nets be allowed to begin in a less depth than 10 feet, or to extend out into a greater depth than 40 feet.

That in the vicinity of the islands at the western end of the lake, the length of pound net strings be further regulated in accordance with local conditions, but in no case should these nets obstruct more than $\frac{1}{2}$ the width of any channel or passageway.

That the use of pound nets be prohibited on any reef or ground on which whitefish or herring are known to spawn, or within a reasonable distance therefrom.

That the use of pound nets be prohibited in any locality where young whitefish may be taken in undue quantity.

That the mesh in all pound nets measure in extension at least $2\frac{1}{2}$ inches in the crib, after shrinkage.

That all pound net stakes be removed from the water within 30 days from the close of the fall fishing season.

Gill nets.—The mesh in the gill nets used for the capture of herring, wall-eyed pike, blue pike and saugers should measure at least $3\frac{1}{2}$ inches in extension, and the employment of any gill net having a smaller mesh should be prohibited.

A very large reduction is called for in the extent of fishing with the small-meshed gill nets, especially for the herring and wall-eyed pike. In case this cannot satisfactorily be accomplished by reducing the amount of netting employed, practically the same result may be reached by instituting a close season, which should preferably occur at the time of year when the greater waste of fish takes place.

We recommend that the use of the small-meshed gill nets be entirely prohibited west of a line connecting Point Pelee with Vermillion Light, between 1st July and 1st January.

In any locality where the small-mesh gill nets are liable to take an undue quantity of undersized whitefish, their use should be prohibited, at least during the period when such undersized fish are there present.

The mesh in the gill nets used for the capture of whitefish should measure at least $4\frac{1}{2}$ inches, in extension, and it is considered that a 5-inch mesh would be preferable.

The quantity of whitefish gill netting now employed appears to be excessive, in view of the continued depletion of the whitefish, and it should be restricted, unless the protection of the species can be better provided for by a close season.

The mesh in the gill nets used for the capture of sturgeon should measure at least 11 inches in extension.

It seems to us that the gill net fishery for sturgeon at the eastern end of the lake is being conducted on too large a scale, and that a reduction should be made in the number of nets employed, but a special investigation will be required to determine the proper means of regulating this fishery. The hook and line fishery for the sturgeon also needs to be taken into consideration in the same connection.

The use of any gill net within one-fourth of a mile of any fixed net, such as a pound net or trap net, should be prohibited.

Fyke nets and trap nets.—The mesh of these nets should conform to the same regulations provided for the pound nets. Their number should be restricted in accordance with the capacity or requirements of each region in which they are fished. A great reduction in the number of the fyke nets is demanded in several places.

Seines.—The dimensions of seines and the size of mesh therein should conform in each instance to the conditions under which they are employed. The mesh should in all cases, be sufficiently large to permit the escape of undersized fish, and the number of seines, as well as the manner of their use, should be properly restricted in all places.

It should be prohibited to fish seines on or about the spawning grounds of the black bass, the pike-perches or other important fishes during their spawning season or while the eggs and young fish continue to remain upon the grounds, and in all other places where the employment of this method would be unduly harmful.

Naked hooks for sturgeon.—It is recommended that the method of taking sturgeon by means of naked hooks or grapnels be prohibited.

Spears.—The use of spears for taking fish of any kind should be prohibited.

Whitefish.—This species is the one most urgently demanding protection as well as efforts to rehabilitate the supply. A large reduction in the amount of apparatus used for its capture, accompanied by extensive fish cultural operations, may be expected to aid materially in replenishing the stock, but we venture to suggest that in our opinion, even greater benefits might be gained by the discontinuance of all fishing for the species during all or a part of its spawning season, as elsewhere explained.

Sturgeon.—All sturgeon measuring less than four feet long, taken by any means should be returned alive to the water.

Black bass.—All fishing for the black bass, including its capture by any means, should be prohibited from at least May 1st to June 15th, and all bass which may be taken in the nets during that period should be returned alive to the water. No black bass measuring less than 10 inches, taken by any method, should be retained or sold.

Pollutions.—The throwing into the water of fish offal, including dead fish taken from the nets, of city garbage and of all other substances deleterious to fish life should be prohibited. Steps should also be taken to prevent injury by the waste from gas works, oil wells, oil refineries, &c., especially in tributary streams containing spawning grounds of important fishes. It is recommended that in connection with all harbour improvements and other work of that character, due precautions be taken in disposing of the materials obtained by dredging, &c., to prevent injury to any fishing grounds.

Propagation.—A continuance of the joint efforts to increase the supply of whitefish by means of artificial propagation is strongly recommended, and it is urged that the scope of this work be increased to the fullest extent possible.

DETROIT RIVER, LAKE AND RIVER ST. CLAIR.

In Lake St. Clair we have, excepting the absence of rocky bottom, the same general physiographical conditions as are found on the platform at the western end of Lake Erie. The lake, with an area of 410 square miles, is essentially a broad shallow expansion of the great stream, composed of the St. Clair and Detroit rivers, flowing from Lake Huron to Lake Erie.

No gill net fishing whatever is carried on within its limits, the movable apparatus consisting solely of hooks and lines, spears and seines. The latter are now prohibited on the Canadian side, and most of those on the United States shore are used in the vicinity of Anchor Bay. Pound nets, fyke nets and trap nets are used, the first on both the Canadian and United States shores and the last two upon the United States side only.

The trap nets, fyke nets and seines in Anchor Bay are the cause of much contention between the Michigan Fish Commission and the sportsmen on the one side and the market fishermen on the other. A large part of the apparatus of the kinds specified is now fished in contravention to the laws of Michigan. The sporting interests in the lake are of considerable importance, and in the delta of the River St. Clair, the well known St. Clair Flats, there are several hotels and many cottages occupied during the spring and summer by persons attracted by the sport, fishing for black bass, perch, grass pike and the rare and highly prized maskinonge. The inhabitants of the neighbouring region supply the sporting population with boatmen and guides, and the produce of their farms and the financial interests represented are very considerable.

In Lake St. Clair the species which have decreased are the herring, whitefish, sturgeon, wall-eyed pike and black bass.

The herring and whitefish run into the lake from Lake Erie by way of the Detroit River, principally in the fall, but in the case of the former, to some extent

at least, also in the spring. The cause of their decrease is no doubt largely connected with the falling off at the western end of Lake Erie and the effects of beneficial regulations there would no doubt be reflected by an improvement in Lake St. Clair. There is no question, however, but that the former heavy fishery for these species in the Detroit River and Lake St. Clair was responsible for a considerable proportion of the decrease. At present the catch of whitefish, although insignificant as compared with former times, is said to be increasing slightly. To what extent the decrease in these species is due to the sewage discharged into the Detroit River from the city of Detroit cannot be stated, but it is not thought to be an important factor as compared with the others mentioned above.

The decrease in wall-eyed pike is less extensive than in the whitefish and herring and is due to a larger extent to local causes, overfishing with fixed appliances and seines and the catching of the young, and the same causes, taken in connection with the grapnel fishery in the Detroit River, have operated to decrease the sturgeon. The fishery for wall-eyed pike and sturgeon in Lake Huron and Lake Erie is not without effect upon the abundance of these species in Lake St. Clair, and an increase in either or both of the two great lakes mentioned would be beneficial to the fishery of the smaller lakes.

The decrease in the black bass is due apparently to excessive fishing, both by sportsmen and by professional fishermen using fixed appliances and seines. It appears that the nets, especially the seines, are most destructive to the black bass in the winter.

In the Detroit River the only commercial fishery is by means of seines and grappling hooks for sturgeon, though a few coarse fish are caught in seines by farmers in the spring. Formerly vast quantities of whitefish were taken in the river, but this fishery became much depleted and is now followed solely by the Canadian and Michigan authorities for the purpose of obtaining eggs for the hatcheries.

In the St. Clair River seines are used upon the Michigan shore for wall-eyed pike and they often catch large quantities of young ones. No nets are used upon the Canadian side. In this river the black bass are speared and seined upon their spawning grounds, and as there is considerable sport fishing at Algonac, St. Clair and other places, this is the cause of much complaint.

RECOMMENDATIONS.

In view of the above mentioned conditions existing in the waters connecting Lakes Huron and Erie, the following recommendations are made:

1. That the use of all nets, excepting seines employed in obtaining whitefish for the hatcheries and seines with not less than 4-inch mesh for catching sturgeon, be prohibited in the waters of the Detroit and St. Clair rivers.
2. That all fishing with seines, traps, or other forms of nets be prohibited in Lake St. Clair north of a line drawn from the mouth of the Clinton River in Michigan to the mouth of the Thames River in Ontario.
3. That the minimum size of mesh in the cribs of pound nets, trap nets and fyke nets be not less than 2½ inches in extension.
4. That no nets whatever be permitted to be used between the 31st day of October and the 1st day of December, excepting for the purpose of the hatcheries.
5. That a close season be adopted for the black bass from May 1 to June 15; that all black bass measuring less than 10 inches long, by whatever means taken, be returned alive to the water; that the number of bass taken by each rod per diem be limited to 20 and that a number of rods to each boat be limited to two.
6. That all sturgeon less than 4 feet long be returned to the water.
7. That all fishing with grapnels or naked hooks be prohibited, but that all other hook and line fisheries be permitted except for black bass between May 1 and June 15.
8. That the throwing into the water of fish offal, including dead fish taken from the nets, of city garbage and of all other substances deleterious to fish life be pro-

hibited. That steps be taken to prevent injury by the waste from saw-mills, gas works, oil refineries, etc.

LAKE HURON.

DESCRIPTION OF THE LAKE.

Lake Huron occupies a central position in the chain of the Great Lakes. It is irregularly crescentic in shape, with the Canadian shore forming most of the outer or greater arc, and the lower peninsula of Michigan, its inner or shorter curve. This crescent lies so that its upper horn is directed westward, connecting with Lake Michigan at the Strait of Mackinac, while its lower point is directed southward and establishes communication with Lake Erie through the river and Lake St. Clair and the Detroit River. At its northern end, about 20 miles east of the Strait of Mackinac, Lake Huron receives the River St. Mary, discharging the overflow from Lake Superior.

On the north-eastern side, Georgian Bay, a large body of water lying entirely in Canada, is almost cut off from Lake Huron by the Manitoulin Islands and the long peninsula terminating in Cape Huron. Somewhat below the middle of the western shore, Saginaw Bay, with an average width of about 20 miles, extends about 60 miles south-westerly into the lower peninsula of Michigan.

The greatest length, following the middle of the lake from the head of the St. Clair River to the Strait of Mackinac, is about 250 miles, and the greatest width, near the middle, about 100 miles. Toward each end the lake becomes much narrower, averaging about 35 miles across in its northern quarter, and for a somewhat greater distance in its southern portion measuring in general about 40 miles in width. Including Georgian Bay, it has an area of about 23,000 square miles.

The United States shores of Lake Huron include the coast of the upper peninsula from False Detour to the Strait of Mackinac, and the eastern side of the lower peninsula as far as Port Huron. Near the shore the bottom is variable in character, consisting of rocks, boulders, gravel, sand, clay and mud, irregularly distributed. Localities suitable for pound nets are scattered at intervals along shore, but are most numerous in Sagnaw Bay.

Lake Huron is divided into two approximately equal areas by the so-called Big Reef, which extends continuously from Point Clark, Ont., to North Point, Michigan. North of the reef the lake has a maximum depth of 125 fathoms; the 30-fathom curve is rarely more than 6 miles from shore, and the 10-fathom curve generally from $\frac{1}{2}$ to $1\frac{1}{2}$ miles, except on the northern side above Southampton, where there are numerous small reefs and islands and much shallow water. The southern portion of the lake is shallower; depths of 30 fathoms and less are more extensive, and the maximum depth is only 54 fathoms. The 10-fathom curve varies from 3 to 8 miles from shore, being most distant off the southern and eastern coasts.

The Big Reef has an average width of 5 miles, and is covered by from 9 to 30 fathoms of water, although a much greater depth is found on each side, especially toward the north.

IMPORTANT FISHES.

In the United States statistical reports relative to the fisheries of Lake Huron, fifteen species of fishes are enumerated. The variations in the relative catch of the

more prominent of these species in 1885, 1890 and 1893, are shown in the following table:—

	1885.	1890.	1893.
1	Trout	Herring	Trout.
2	Whitefish.	Trout.	Herring.
3	Herring	Perch*	Suckers.
4	Wall-eyed pike and grass pike.	Wall-eyed pike and grass pike.	Perch.
5	Catfish.	Suckers*	Whitefish.
6	Sturgeon	Whitefish.	Wall-eyed pike and grass pike.†
7	Black bass	Sturgeon	Catfish.
8	.....	Catfish.	Sturgeon.
9	.....	Black bass.	Black bass.

* Perch and suckers were not separately enumerated in 1885.

† The proportion of grass pike was less than 10 per cent.

The relative importance to Canadian fisheries of the five principal species in different years is brought out by the following table, in which the several forms are enumerated in the order of the size of catch:—

1880.	1885.	1890.	1894.
Whitefish.	Herring.	Trout.	Trout.
Trout.	Whitefish.	Herring.	Herring.
Herring.	Trout.	Whitefish.	Sturgeon.
Wall-eyed pike.	Wall-eyed pike.	Sturgeon.	Whitefish.
Sturgeon.	Sturgeon.	Wall-eyed pike.	Wall-eyed pike.

LAKE TROUT.

Status.—At the present time the lake trout is the most important species taken in the fisheries of Lake Huron. In 1893 it constituted about 29 per cent of the total catch and 44 per cent of the value of the fisheries on the Michigan shore. In Canadian waters it has also attained first rank in both quantity and value. It is caught chiefly in gill nets, and comprises 90 per cent of the total catch by that means in United States waters.

Varieties.—The fishermen recognize a number of varieties of the lake trout, the most of which, however, are not definable. One, occurring sparingly in the deeper water in the northern part of the lake approaches the siscowet of Lake Superior in fatness and quality. The bulk of the catch consists of two widely recognized forms, the deep-water trout and the large shoal-water or fall trout.

Distribution and movements.—If we except Saginaw Bay and the region south of the parallel of Goderich, there is probably no time in the spring, summer or fall when vessels fishing out of the ports of either Michigan or Canada would fail to obtain trout in gill nets having the proper size of mesh. In the early spring they occur in moderate depths along shore on both sides of the lake, but after the middle of June they are mainly on the borders of the coastal platform and especially on the edges of the Big Reef. About the middle of September or a little earlier they move into the shallower water on the reefs and along shore, retiring to deep water late in November.

The foregoing applies, in a general way, to the great body of fish. It is evident, however, that many remain in the deep water during the summer and fall, and at all seasons the species may be caught in rather shallow water. Even in winter, trout are taken through the ice in moderate depths off Iosco and Huron counties, Michigan, by means of set-lines and gill nets, and in the neighbourhood of Detour by gill nets. There is similar diversity in the vertical distribution, independent of the depth of water. They appear at one time or another to swim at all levels from the bottom to the surface, although the nets are only set for them on the bottom.

The only pronounced movement appears to be shoreward and on to the reefs in the fall for spawning. At that time the trout do not seem to travel any considerable distance, but only to proceed from comparatively deep water to the nearest shallows. There are, apparently, at least two, and perhaps more, distinct bodies of fish concerned in this movement. The first or early run is composed of what the fishermen term shallow water trout, and upon certain grounds these fish will run into 3 or 4 and sometimes even 2 feet of water. The later run does not approach so close to shore, and is more extensively represented on the reefs.

Spawning.—The spawning grounds of the trout in Lake Huron seem to be, in a measure, co-extensive with the general distribution of the species. That is, the fish spawn along the shores at all suitable places near which they are usually found at other times, and the spawning migration is probably a mere shifting of the fish from their accustomed summer habitats to some near-by reef or shore favourable for depositing their eggs.

There are no spawning grounds of importance on the Michigan shore south of Port Austin. On the Canadian side the most important regions for spawning trout are north of Southampton, and the south side of Grand Manitoulin. The former is one of the best localities on the lake for "shoal-water" trout. The greatest of all the spawning grounds in Lake Huron is the Big Reef, which stretches across the lake from North Point, Thunder Bay, to Point Clark, in Canada. During the summer the fish begin to aggregate upon the edges of the reef, but in the height of the spawning season they seek the shallowest portions and are caught in great numbers by tugs from both sides.

In September, the time varying from the 15th to the 25th of the month, the shoal-water trout come ashore near Alpena, Port Austin and Southampton, and usually occupy about two weeks in spawning. The late run, which comes upon the reefs as well as along shore, spawns between about October 10 and the latter part of November, the season being somewhat later in the northern part of the lake than off Alpena and Southampton. This run is heavier than the preceding. The intervals between the several runs are not sharply defined, being bridged over by the belated fish of the earlier and the precocious individuals of the later schools.

Food.—The trout devour large numbers of herring, shiners, and other species, and it is said that a good many young whitefish are sometimes found in their stomachs.

Decrease.—The testimony of the fishermen respecting the question of decrease is exceedingly contradictory. On the Michigan shore, according to the statements of the majority, there has been a greater or less falling off in the supply, while in Canada the general opinion seems to be that the decrease, at the most, has been very slight and largely confined to the fall or shoal-water variety.

From a statistical standpoint, the history of the trout fishery in United States waters can be traced back only to 1885. The catch of trout in pound nets in 1885 is not recorded, but estimating it upon the basis of the statistics for 1893, the following table will give the relative catch by gill nets and other methods for each year recorded:—

	1885.	1890.	1893.
Gill nets.	2,336,000*	1,421,827	3,243,800
Other methods.....	203,780*	329,202	267,715
	2,539,780	1,750,619	3,511,575

* Estimated.

Our investigation shows that between 1885 and 1893 the average catch per gill net has fallen off but 6 per cent, while the averages for the years 1890 and 1893 agree quite closely. A comparison of the average catch by the pound nets in 1890 and 1893 would seem to indicate a falling off about 25 per cent in the shore trout within three years, but the data are not sufficient to serve as a satisfactory basis for conclusions.

The statistical returns for the Canadian side of the lake for 1880, 1885, 1890 and 1894, show the following catches to have been made in those years:

1880.....	469,000 lbs.
1885.....	712,954 "
1890.....	1,409,150 "
1894.....	1,563,270 "

These figures indicate a continuous increase in the size of the catch, but there was, as upon the United States side, an increase in apparatus also. The catch by pound nets may safely be ignored, as this form of apparatus is confined to the southern end of the lake where very few trout are taken. Assuming, therefore, that the entire catch was made in gill nets, we obtain the results shown in the following table:

Year.	Fathoms of Gill Net.	Catch per 100 Fathoms.
		Lbs.
1880.....	54,417	862
1885.....	61,253	1,162
1890.....	132,200	926
1894.....	222,650	711

Considering the lake as a whole, it is probable, although not proven, that a slight decrease in the abundance of the trout has taken place, and it may be assumed that this decrease has been greater in the catch of shoal-water trout, while the deep-water fishery has been fairly well maintained.

WHITEFISH.

Status.—On the Michigan shore, in 1893, the whitefish ranked fifth in the amount and third in the value of the catch. In 1890 it held sixth place in the amount and in 1885 second place. In the early history of Lake Huron it was the

most important species. On the Canadian side it stood fourth in 1894, third in 1890, second in 1885 and first in 1880.

Most of the whitefish are caught in pounds. The following table shows the proportion taken by each form of apparatus in 1893 in United States waters:—

Pounds.....	76.1 per cent.
Gill nets.....	23.9 do

Distribution and movements—Whitefish are found along the entire shore of Lake Huron wherever the depth is less than 35 fathoms. They are taken at greater depths but sparingly, and the best fishing is usually in from 10 to 25 fathoms. They are most abundant in the vicinity of the Manitoulin Islands and the Straits of Mackinac, and in 1893 about 67 per cent of the total catch on the Michigan side of the lake was made, chiefly in pounds, in the four counties of Chippewa, Mackinac, Cheboygan and Presqu Isle. The vicinity of Drummond Island may be considered the most important whitefish ground in United States waters. Alpena county is next in importance to those mentioned, followed by Huron and Iosco. In the first two most of the fish are caught in gill nets, and in the last two in pounds. In the remaining seven counties this fishery is inconsiderable.

On the Canadian side most of the whitefish are caught in gill nets, although some are taken in the pounds south of Goderich during the latter part of May and early in June. The gill net grounds extend from Goderich to Cape Hurd, the best fishing being between Southampton and Stokes Bay. The pound nets at the Duck Islands also catch them, and gill nets are fished extensively in the same region.

The whitefish is rarely taken on the Big Reef or at any other place far from shore.

The movements of the whitefish in Lake Huron are, in general, less definite than in Lake Erie, being confined to shoreward migrations in the spring and fall. These migrations appear to be accompanied by no extensive progress along shore, except at Detour, where the spring run is said to have a general easterly direction, appearing first near Detour, and then passing down the north channel into Georgian Bay. In this region the catch is larger during May and June than at any other period, and, except where the fishery is carried on during the spawning season, this statement holds for the rest of the lake.

Little is known of the whereabouts of the whitefish during summer and winter, but that they are not all in deep water at those seasons is shown by the fact that they are caught in small numbers near Detour in the winter, and off Port Sanilac during the summer.

Spawning.—The spawning of the whitefish takes place almost entirely in the shore waters, principally between November 1st and 25th. No ripe fish are caught on Big Reef, and very few on Spectacle Reef. Spawning grounds are found at intervals on rocky or sandy bottom from Detour to Port Austin, and a small number of whitefish are said to spawn off Port Sanilac. The Canadian fishermen do not admit that there is much spawning anywhere on their shore, but a few fish are known to spawn at Cape Ipperwash, in the vicinity of Southampton, at the Fishing Islands and probably near the Duck Islands. This species sometimes deposits its eggs in depths of only 4 or 5 feet.

Decrease.—When the fisheries first began on Lake Huron, their principal object was the capture of whitefish which were then exceedingly abundant. According to the fishermen their numbers exceeded that of any other species, but it is doubtful if this statement is strictly true.

In all parts of the lake the fishermen are practically unanimous in the statement that the decrease has been very great. At Detour the low-water mark is said to have been reached about 1884; since then there is supposed to have been a yearly increase due to artificial propagation. There is little information as to the exact time of the failure of this fishery at other places, but, with the exception of Detour, the general impression is given that the decrease has continued to the present time.

1893.

27	3,243,800
2	267,715
19	3,511,575

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Statistical evidence concerning the question in United States waters is available for only three years, 1885, 1890 and 1893, when the total catches of whitefish were as follows:—

1885.....	1,425,380 lbs.
1890.....	1,033,158 "
1893.....	1,190,271 "

Compared with 1885, 1893 shows a decrease of about 16 per cent, and with 1890 an increase of 15 per cent, in the gross catch.

Dividing the United States coast into two regions, one embracing the four counties in the vicinity of the Strait of Mackinac, and the other including the rest of the Michigan shore, we obtain the following results, regarding the catch of 1885 as 100.

Counties.	1885.	1890.	1893.
Chippewa, Mackinac, Cheboygan and Presque Isle.....	100	72.6	109.8
All other counties.....	100	72.3	62.7

From the above figures it will be seen that the decrease from 1885 to 1890 was about equal in the two sections, but from 1890 to 1893 there was a further decrease from Alpena county southward, while in the northern four counties the catch was approximately the same as in 1885. The best statistical test of a decrease is a comparison of the average catches per unit of apparatus for the several years for which statistics are available. This is not possible for 1885, as the catches by the several means were not differentiated, and for 1890 and 1893 the records of the pound nets only can be used with any approach to accuracy. In the northern counties, where, as shown above, the total catch has increased since 1890, we find that during the same period there has been a decrease of from 27 to 68 per cent in the average catch per pound net, the corresponding decrease in all other portions of the lake being nearly 17 per cent.

The amount of the catch for each of four years in Canadian waters was as follows:

1880.....	762,000 pounds.
1885.....	921,543 "
1890.....	442,020 "
1894.....	187,000 "

The following table shows the number of fathoms of gill nets, the number of pound nets and the catch of whitefish for each of the same years, computed upon the basis of 1880 as 100 per cent:—

Year.	Length of gill nets.	No. of Pounds.	Catch of Whitefish.
1880.....	100	.....	100
1885.....	113	100	121
1890.....	270	463	58
1894.....	400	388	26

It will be noticed that while the pounds in 1883 and 1894 are as 1 to 4, and the gill nets in 1890 and 1894 are in about the same proportion, the catch of whitefish in the same years is as 4 to 1. Notwithstanding, therefore, the quadrupling of the apparatus in the last fifteen years, the total catch has been reduced three-quarters. There can be no escape from the conclusion that the decrease in this species has continued to the present time.

LAKE HERRING.

Status.—Since 1885 the product and the value of the herring fishery have increased both absolutely and relatively, and in 1893 this species ranked second on both sides of the lake. The pound nets make practically the entire catch, only a very small percentage having been taken by other means in 1893. The extent of herring gill netting in the lake is very small, and on the United States side these nets are used only in Sanilac county. The Menominee nets in Cheboygan and Mackinac counties caught about 10,000 pounds in 1893, but the whitish and trout nets are altogether too large to mesh this species. Compared with Lake Erie the catch of this lake is insignificant, having amounted to only 2,732,628 pounds in 1893.

Distribution and movements.—The herring is not abundant in the northern parts of Lake Huron, although Mackinac and Cheboygan counties showed a largely increased catch of this species in 1893, more being caught in those counties than in any other locality north of Saginaw Bay. In 1893 the catch on the United States shore was distributed as follows:—

Locality	Catch.	Percentage of total catch.
North of Iosco county	324,221	11.8
Iosco county and southward	2,408,407	88
	2,732,628	100.0

The centre of the herring fishery of Lake Huron is in Saginaw Bay, and over 70 per cent of the entire United States catch is taken in the six counties contiguous to its waters. On the Canadian side the herring are distributed from the head of the St. Clair River to Cape Hurd. South of Goderich they are caught principally in pounds, but northward they are taken entirely in gill nets, the fishery being followed only a short time during the spawning season.

The movements of the herring in Lake Huron are not very well defined. In the spring and early summer there is a migration of a comparatively small body of fish up the St. Clair River. This run, which is caught late in June and early in July in the vicinity of Port Huron and Sarnia, is composed of large fish, resembling those taken in Lake Erie.

In the spring the general run of the small Lake Huron herring comes ashore about the middle of April and lasts throughout May and June, May being the month when they are most abundant. This shoreward movement takes place along the entire margin of the lake, but is most marked in Saginaw Bay and southward. During the latter part of June the shoal water becomes warm and the fish leave, not returning again until the latter part of September. In October they become more abundant, but the best fishing of the year occurs during November, and there is usually an abundance of herring until the pounds are removed toward the end of that month.

From the middle of October until about November 15th, gill netters carry on a fishery for herring in the vicinity of the Ghegheto or Fishing Islands, the fishermen from Southamptom and other Canadian ports making temporary camps along shore, from which to prosecute their calling. This fishery is close inshore and is carried on from boats only.

Spawning.—The spawning run of herring appears to come inshore around the entire margin of the lake, but the most extensive and constant grounds are located in Saginaw Bay and around the Ghegheto Islands. The spawning season is supposed to be mainly from November 5 to 25.

Decrease.—The general opinion of the fishermen is to the effect that the supply of herring has increased on the Michigan shore south of Alpena, and has decreased on the Canadian side of the lake between Sarnia and Cape Hurd. The views expressed respecting the former region are substantiated by the fact that, exclusive of Chippewa and Mackinac counties where few herring are caught, the average catch per pound not shows a steady increase since 1885, amounting to 90 per cent in 1893.

According to the Canadian statistics catches of herring have been made as follows:

1880.....	183,200 lbs.
1885.....	1,220,600 "
1890.....	1,386,700 "
1894.....	478,200 "

The catch of 1894 is greater than that of 1880, but was taken by a much greater amount of apparatus. The intermediate years appear to have been exceptional for fishing on the Canadian shore, not only for the herring, but for other species as well.

Considering the entire length as a whole, it may safely be affirmed there is no evidence of a decrease in the herring supply.

WALL-EYED PIKE.

Status.—The wall-eyed pike held sixth place in the amount, the fourth place in the value, of the catch in United States waters, in 1893. It was fifth in the size of the catch in Canadian waters, in 1894. On the United States side the catch was distributed by apparatus as follows:

Apparatus.	Amount of Catch.	Percentage of Catch.
	Lbs.	
Pounds.....	686,952	90.6
Hand seines.....	30,445	4.0
Fyke nets.....	24,883	3.3
Spears.....	11,812	1.6
Gill nets.....	3,426	0.5
	757,518	100.0

Distribution and movements.—The wall-eyed pike is local in its distribution, its centre of abundance being in Saginaw Bay and River, where 82 per cent of the total catch on the Michigan shore was taken in 1893. Relatively small quantities are caught on the north shore and near the St. Clair River, but practically none are

taken elsewhere. It is said sometimes to run into Saginaw Bay and River, in small bodies during thaws in January, February and March, but this run is composed almost entirely of small fish. About April 5 the adult fish come in and pass to the head of the bay for spawning. In this latter locality fishing is good from the time the nets are set until about May 10th or 15th, and after that a few are caught until the first or middle of June, but further down the bay they remain until July. Very few wall-eyed pike are caught in Saginaw Bay after July, but a limited run of small fish enters the bay in the fall.

Spawning.—This species runs into bays, rivers and small streams for the purpose of depositing its eggs. Some schools enter the streams on the north shore, and others the St. Clair River and some of the creeks at the southern end of the lake, but the bulk of the fish spawns either in Saginaw River or in the bay of the same name. Spawning begins early in April and lasts from 10 to 20 days, usually being concluded before May 1st.

Size.—It is stated that the wall-eyed pike caught in Saginaw River average only 4 to 5 ounces each, and that four-fifths of the fall catch in Saginaw Bay weigh less than one pound.

Decrease.—At most places where the fishermen expressed opinions on the subject it was generally agreed that the wall-eyed pike had decreased. This species, however, appears to be subject to greater fluctuations from year to year than are most others of the lake fishes, and although it may be scarce in any given locality for a number of years, it is liable to return suddenly in comparative abundance.

The catch in United States waters in the three years for which we have statistics, including also a small portion of grass pike, was as follows:

1885.....	940,500 lbs.
1890.....	1,483,072 "
1893.....	827,819 "

Nearly the entire catch in these years was made in pound nets, and we find that the annual average catch per net shows a heavy decrease in 1893 as compared with 1885, although the catch was much larger in the intermediate year, 1890 than in either of the others. The erratic behaviour of this species makes it difficult to estimate its present status as compared with the past, except with the use of more complete data than are now accessible, and it is, therefore, impossible to measure the extent of decrease.

STURGEON.

Status.—The sturgeon is of minor importance on the United States side of Lake Huron, where, in 1893, only about 80,000 lbs., valued at about \$2,000 were obtained. On the Canadian side, however, the catch in 1894 amounted to 370,000 lbs., and was exceeded only by those of the lake trout and herring. Prior to 1875 this species had no value and was generally regarded as a nuisance, but the price per pound now paid for it is but little lower than that of the trout.

Distribution and movements.—In 1893 sturgeon were caught in every county on the Michigan shore, with the exception of Alpena, where, however, 50,000 lbs. were obtained in 1890. In 1893, over two-thirds of the entire United States catch was made south of Saginaw Bay, and on the Canadian shore most of the sturgeon are also taken in the southern part of the lake, especially in the pound nets in the vicinity of Sarnia. The bulk of the catch is made during June and July, but a limited number is secured in September. At other seasons the species does not occur inshore, and it is probable that at such times they are scattered over the deeper portions of the lake, where they are occasionally caught in the trout nets.

Spawning.—The sturgeon spawn principally on the sandy bottoms at the southern end of the lake, during June and July, but well developed spawn suitable for caviar is found in them throughout the year.

Decrease.—There is no question but that the sturgeon has undergone a most remarkable decrease since the beginning of the fishery. The catches for the years embraced in the statistical returns for the United States shore were as follows:—

1885.....	215,500 lbs.
1890.....	365,718 "
1893.....	79,553 "

The increase in 1890 occurred in all parts of the lake south of the four counties near the Strait of Mackinac, having been greatest in Saginaw Bay and in St. Clair county. During the same period there was a marked decrease in the catch on the northern part of the Michigan shore. In 1893 there was a decrease along the entire Michigan shore, but the greatest falling off was in Saginaw Bay, where 179,000 lbs. were taken in 1890, and only 8,183 lbs. in 1893. Owing to the nature of the statistical returns it is not possible to show the catch of sturgeon per unit of apparatus, but the general extent of the decrease may be gathered from the decline in the total catch. Most of the sturgeon are obtained in pounds, but there is one seine credited with a large catch in St. Clair county.

The Canadian catches during four years were as follows:—

1880.....	5 000 lbs.
1885.....	347,800 "
1890.....	223,750 "
1894.....	370,675 "

In 1880 there were few seines and no pound nets in use, and practically no sales of this species, which accounts for the small catch recorded. In 1885 there was a great increase in the number of seines; in 1890 the pounds increased and the seines diminished in numbers, and in 1894 the latter were entirely prohibited, their place being taken by additional pound nets. These figures may be taken to indicate that the catch of sturgeon on the Canadian shore has been fairly maintained since 1885.

Gill Nets.

Introduction.—The gill net fishery of the United States side of Lake Huron, in 1893, yielded 3,534,028 lbs. of fish, valued at \$136,714. This represents about 30 per cent in quantity and about 45 per cent in value of the catch by all methods on the Michigan shore of the lake. The species taken, arranged in the order of the size of catch, are lake trout, whitefish, menominee, whitefish, herring, pike, suckers and perch. The last three species enumerated are not the objects of special pursuit by this method, but are taken incidentally in the fisheries for other species.

Trout fishery.—This ranks as the most important gill net fishery of Lake Huron. In 1893 it yielded 3,171,860 lbs. of trout, being 92 per cent of the entire catch of that species and 90 per cent of the total gill net catch in United States waters. It is prosecuted both by small boats, which confine their operations to the vicinity of the shores, and by tugs, which are able to run longer distances and to set their nets in the deep waters and on the reefs in the centre of the lake. The number of nets fished from boats slightly exceeds that fished from tugs, but they catch only about one-half as many fish. No data are at hand to show the exact amount of trout gill netting fished, the statistics making no distinction between the nets of different sizes of mesh, but practically all are of sufficient size for trout and are used for that species during the greater part of the year.

The following table shows the number of tugs of over five tons burden, the amount of gill netting fished by them and the amount fished by boats, in the different counties on the United States side of the lake.

County.	Tugs.	Total tonnage.	No. of Nets on tugs.	No. of Nets on boats.	Total No. of Nets.
Chippewa.....	3	42-53	232	236	468
Mackinac.....				213	213
Cheboygan.....				260	260
Presque Isle.....				193	193
Alcona.....	3	71-80	812	579	1391
Iosco.....	2	18-70	541	303	844
Arenac.....					
Bay.....					
Tuscola.....					
Huron.....	2	19-32	316	784	1100
Sanilac.....				51	51
St. Clair.....	2	52-83	523		523
	12	205-18	2424	2619	5043

In addition to the 12 tugs enumerated, there are several others which, being under 5 tons measurement and not registered, are considered in the statistical returns in connection with the shore fisheries. Tugs from Detroit fish in Lake Huron, and during 1893 took 100,000 pounds of trout, which were not included in the catch of this lake. Several tugs from Potoskey also fish to a considerable extent in Lake Huron, making their headquarters generally at Cheboygan.

On the Canadian side there were 9 tugs and a number of boats engaged in the fisheries in 1894, using altogether 222,650 fathoms of netting. The tugs have their headquarters at Goderich, Southampton, Tobermory and the Duck Islands.

Fishing begins in the spring as soon as the lake is sufficiently clear of ice and continues without interruption until the ice begins to form again in the fall. During the summer the fishery is less active than in the spring and fall, and after 10th November many fishermen abandon it on account of the closing of navigation and the consequent lack of means of shipping the catch. There is a small winter gill net fishery under the ice in the northern part of the lake.

During the spring and summer, fishing is conducted along the entire United States shore north of Sanilac, with the exception of Saginaw Bay, but on the Canadian side there is no fishery at any time south of the Big Reef. In the summer and fall the best fishing is on the reefs, and later in the season in the deep waters to the north of the Big Reef. The United States fishermen cover the entire region to a distance of from 30 to 50 miles from the Michigan shore; the Canadians operate in a similar zone on the other side of the lake, from the Duck Islands to the Big Reef.

Whitefish Fishery.—The catch of whitefish in gill nets is second only to that of the trout, although much inferior to it. On the Michigan shore, in 1893, only 8 per cent of the total gill net catch consisted of whitefish, 169,518 lbs. being taken by boats and 121,251 lbs. by tugs. In the yield of whitefish the gill nets were much inferior to the pounds, the catches being respectively 24 per cent and 76 per cent of the total.

In the northern part of the lake, on the Michigan side, the whitefish gill netting is of little importance and many of the fish taken are incidental to the fishery for trout, most of them being caught during June, July, August and September. It is noteworthy that in this region over 75 per cent of the pound net whitefish are captured, the pound nets in Chippewa county alone taking over 100,000 lbs. more than all the gill nets in United States waters. Alpena county furnished the most important whitefish gill net fishery on the Michigan shore. In 1893, 127,919 lbs. were landed there, the tugs securing two-thirds and the boats the remainder. No whitefish are obtained in gill nets in Alcona, Sanilac and St. Clair counties, nor in Saginaw Bay, but in both Iosco and Huron counties at the mouth of the bay good

catches are recorded, the boat fishery of Huron county being the largest on the Michigan shore.

The bulk of the whitefish gill netting on the United States side is, therefore, found in that portion of the lake south of the Big Reef, north of Saginaw Bay and west of Sand Beach, and even in this circumscribed region the fishing is confined almost entirely to depths of less than 25 fathoms. In the spring the whitefish are taken by both boats and tugs, the latter usually fishing somewhat further from shore than the former. In the fall the fish come near the shore to spawn and good catches are then made on the inshore grounds. There is no fishery for this species on the Big Reef.

On the Canadian side of the lake whitefish are taken in gill nets off the south side of the Manitoulin Islands and along the eastern shore between Bayfield and Cape Hurd. On the eastern shore, Goderich, Kincardine and Southampton are the principal ports from which the fishery is followed, the nets being set in less than 30 fathoms on sandy and muddy bottom, during the months of May, June, July and August.

In the northern part of Lake Huron, on both sides of the boundary line, there is a small gill net fishery for whitefish through the ice. But a few persons engage in this fishery and each man owns only a small amount of netting.

Menominee fishery.—Under this heading is included the catch of several small species of whitefish in the vicinity of the Strait of Mackinac. Three species appear to be represented, namely, the menominee whitefish, *Coregonus quadrilateralis*; the long-jaw, *Argyrosomus prognathus* and the bluefin, *Argyrosomus nigripinnis*. Small specimens of the common whitefish are also said to be taken with them at times. Collectively the gill net catch of these several species on the Michigan shore in 1893 amounted to 37,425 lbs., only a little over 1 per cent of the total yield of the gill nets. Mackinac and Sanilac counties are the only places from which menominees are recorded in 1893. In Sanilac county the catch was very small and probably consisted largely of small whitefish and large herring; and some of the fish recorded from Mackinac county may have been brought from Lake Michigan.

There are no records of the catch of menominee whitefish by gill nets in Canadian waters.

Herring fishery.—The entire catch of herring by gill nets in United States waters in 1893 amounted to only 26,000 pounds, being less than 1 per cent of the total yield of the gill nets during that year. Mackinac and Sanilac counties are credited with the bulk of this catch, 15,000 pounds, being recorded from the former and 7,500 pounds from the latter.

On the Canadian side herring gill nets are fished from the ports of Goderich and Southampton. The fishermen from both places fish them under the ice during the winter, but men from Southampton use them also during October and November. Most of the fall fishery is carried on near the Fishing Islands and thence up the coast to Cape Hurd, the nets being set in extremely shallow water, often barely deep enough to cover them. The fishermen erect temporary stations along shore and it is said that during November, which is the principal season, as many as 40 or 50 boats are fishing in the region above mentioned. Each boat uses from 6 to 12 nets, varying from 240 to 300 feet each in length.

History and quantity.—Gill net fishing on the Michigan side of Lake Huron appears to have been begun in the vicinity of Alpena. In 1835 a few float and stone nets were fished there, and before 1850 this method of fishing had spread along the coast from the Strait of Mackinac almost to the River St. Clair. At first the gill nets were used almost entirely for whitefish and the fishery was confined to shore waters, but after the decrease of that species more attention was given to the trout. This required longer trips at certain seasons of the year and naturally led to the introduction of tugs for fishing on offshore grounds, though sailboats still continued to operate inshore.

The first fishing tug was built in 1860, but the first authentic record of a tug actually fishing gill nets was in 1874. In 1882 there were at one time 9 tugs fishing out of Alpena, most of them probably being from other lakes. They appear also to have been used occasionally from Cheboygan. The statistics record 7 tugs on the United States side in 1885, and only 3 in 1890. During the next three years this branch of the fishery increased, and in 1893 there were 12 tugs all told, fishing from Detour, Alpena, Oscoda, Au Sable, Port Austin and Port Huron, but those at Detour did not engage in gill netting with the constancy of those owned at other ports.

The amount of gill netting, according to the statistics, underwent a considerable reduction from 1885 to 1890, but the returns for 1893 show an increase in the number of nets, amounting to 129 per cent as compared with 1890 and to 47 per cent as compared with 1885. This increase involved both the boat and vessel fisheries and manifested itself on all parts of the Michigan shore, although it is most pronounced between Alpena and Port Huron, where the gill netting has always been most important. It should be remembered, however, that the tugs from Petoskey fish from Cheboygan county and there has doubtless been a considerable increase in the number of nets fished in that locality, although it would not appear in the statistics.

The number of nets fished during the years in which statistics were taken was as follows;—

1885.....	3,414
1890.....	2,206
1893.....	5,043

It is not possible, from the information at hand, to tell the size of mesh of this netting, but nearly all of it was of a size suitable for trout and whitefish.

Southampton appears to have been the first port on the Canadian shore from which gill nets were fished. This was probably only a short time prior to 1855, when three boats with three men each were fishing from that place. The fishery steadily increased, until about 1882 there were 24 sail boats engaged in it, and coincident with its growth in that locality there was an increase along the other parts of the shore, especially at Goderich. There appears never to have been much gill netting south of Bayfield. There were 33 boats and no tugs on the Canadian side in 1880, 86 boats and no tugs in 1885, 131 boats and 10 tugs in 1890, and 92 boats and 9 tugs in 1894, not including those fished at the Duck Islands at the northern end of the lake. The number of nets shows a steady increase during the years covered by the statistics, the figures being as follows at four different periods:—

1880.....	54,417 fathoms
1885.....	61,253 "
1890.....	152,200 "
1894.....	222,650 "

Rigs.—The trout nets are about 15 meshes or 6 feet deep, the whitefish nets from 18 to 20 meshes and the herring nets from 40 to 60 meshes deep. The length varies considerably in different places, but, in general, it may be said that the nets are now fished in greater lengths than when they were rigged with floats and stones.

On the United States side the tugs usually have three gangs, or from 15 to 18 miles, in the water at all times. In Canadian waters it is the custom to fish from each tug about 20 miles of trout and whitefish nets in 4 gangs, or about 6 miles of the large trout nets in 3 gangs. The boat rigs are about one-half as long as those of the tugs fishing in the same locality, and the nets are separated into 3 or 4 gangs. At the Fishing Islands the boats use from 6 to 12 herring nets apiece, each net varying in length from 240 to 300 feet.

Size of mesh.—Three classes of nets, as regards the size of mesh and thread, are used in Lake Huron, namely, a large mesh for the fall trout, a medium mesh for trout and whitefish, and a small mesh for herring and menominee whitefish.

The large mesh nets, of stouter thread, are used during September and October. On the Michigan shore, the mesh measures from 5 to 5½ inches, and in Canada, from 5½ to 6 inches.

The medium mesh nets are practically the only ones used for trout as well as whitefish, except during the fall. The mesh varies in size from 4½ to 4¾ inches, most of the fishermen using 4½ inches.

The herring nets used at Port Sanilac and on the eastern shore of the lake, have 2¾-inch mesh, and the menominee nets in the vicinity of the Strait of Mackinac, a 3-inch mesh.

Time out and condition of catch.—In most places, in the spring, the nets are left to fish for five days before being lifted, but during summer, it is the practice to leave them out only three days on the United States side, and four days on the Canadian. The sailboats usually keep their nets in the water one day less than the tugs in the same region. In general, therefore, the fish are permitted to remain in the gill nets for a much longer time in Lake Huron than in Lake Erie. Notwithstanding this fact, however, owing to the colder water and the firmer character of the fish, there is not much complaint of the quality and condition of the gill net catch in this lake. When no untoward circumstance, such as storms, prevents the lifting of the nets at the regular time, there are comparatively few fish unfit for market, although there are usually some too soft to be transported without salting.

Losses by storms.—A smaller proportion of nets is lost through storms than in Lake Erie, the principal damage to the gear resulting from the cutting of the nets on the rocky bottom at the north, or having them filled with dirt, clinkers and drifting snags at the south. Nets fished in shallow water are more liable to these mishaps or to be carried away by the currents than those set in the deeper parts of the lake, to which not even the most violent disturbances can penetrate, and, consequently, the loss of nets is greatest in the southern portion of the lake, along the shore between Goderich and Cape Hurd, and in the shoal water fisheries in the vicinity of the Strait of Mackinac.

In certain parts of the lake considerable damage is done to the gill nets by accumulations of bark derived from the logs rafted from the Canadian shore to the United States. The grinding of the logs against one another during rough weather, dislodges not only the outer bark, but large quantities of the fibrous inner bark as well. The nets collect this material, and when taken ashore to dry, become rolled up and ruined by the curling of the fibre entangled in the thread. It is impossible to remove this material by any process, such as is efficacious in cleaning off the slime, for the chemical composition of the fibre resembles that of the thread, and any treatment which would remove the former would destroy the latter.

POUND NETS.

History and quantity.—Pound nets were used in Lake Huron as early as 1854, but they increased more slowly than in Lake Erie, and even at the present time the fishing stations are much scattered. This is due partly to the sparsely settled shores and partly to the absence of fish and the unsuitable character of the bottom in many places.

Little is known respecting the history of the pound nets on the Michigan shore prior to 1885. Regarding this shore as a whole, we find that there has been a steady increase in the number since 1885, and in 1894 there were 603 in all, an increase of 30 per cent as compared with 1885, and of over 9 per cent as compared with 1890. This increase was most marked on the north shore, in Cheboygan county and at the south near Port Huron. In Saginaw Bay there was but little change, while between Hammond Bay and Saginaw Bay, comprising Presqu Isle, Alpena, Alcona and Iosco counties, there was a marked decrease. These changes are shown in the following table:—

NUMBER of pound nets in the United States waters of Lake Huron.

Region.	1885.	1890.	1894.
North shore (from St. Ignace to Drummond Island, including north shore of Bois Blanc Island)			
Cheboygan County	41	53	140
Presque Isle, Alpena, Ancona and Iosco counties	4	25	41
Saginaw Bay	83	71*	28
Saginaw Bay to St. Clair River	320†	367	352
	14	36	42
	462	552	603

* Decrease in Alpena County and increase in Iosco County.

† Estimated.

About 1882 the first pound nets on the Canadian side of the lake were built south of Goderich and at the Duck Islands. At the extreme southern end of the Canadian shore none were licensed before 1894, but in that year seines were prohibited and the fishermen were permitted to use pound nets instead. In 1894 there were 27, fished in stands of one each, between Sarnia and Lakeview, but no others were used on the eastern shore.

Description.—The pound nets are of the same general construction as in Lake Erie. The length of the leaders varies somewhat with the location and the slope of the bottom; in Saginaw Bay and near Sarnia they are usually between 60 and 85 rods long, while most of those elsewhere are between 35 and 60 rods long. The majority of the cribs are between 26 and 30 feet square, but there are a few as small as 18 by 20 feet and as large as 44 feet square.

The depth of water in which the cribs are set varies with the character of the coastal platform. In Saginaw Bay the great majority are in from 8 to 15 feet of water. South of Saginaw Bay on both sides of the lake most of the nets are in from 20 to 30 feet, and in the northern region in from 25 to 50 feet, the maximum being 90 feet.

On the Canadian side the nets are all set singly, but on the Michigan shore there is a tendency to use as many pounds in a string as possible. The maximum in this respect is reached in Saginaw Bay, where there is one string of twenty-two nets, one of seventeen and two of ten nets each. All others contain less than nine and over half of them between three and five each. In no other part of the lake are there more than five in a string, and in most places the number does not exceed three.

From Detour to St. Ignace and from Mackinaw City to Hammond Bay the mesh in the cribs varies from 2 to 3½ inches, the latter size being the most common. From Hammond Bay to Oak Point most of the nets have the mesh 2½ inches in the front and sides of the crib and 2 inches in the back. From Oak Point to Port Huron the usual size is 3 inches in the front and sides and 2½ inches in the back. The leaders are commonly of 6-inch netting, but a few fishermen use 5, 7 or 8-inch mesh. Most of the hearts and tunnels measure 5 inches, but a few nets have 4 and 4½-inch mesh.

On the Canadian shore the mesh in the cribs is 2½ inches, that used in the other parts of the nets being of the same general dimensions as on the Michigan side.

Seasons and Catch.—In most places on Lake Huron the nets are in use only during the spring and fall, but these seasons are not so sharply defined and uniform as in Lake Erie. There is no legal close time on the Michigan side of the lake, and where a summer close season is observed it is because fish are few and the water is so warm as to injure the twine.

Owing to the difference in dates of the beginning and ending of fish operations in different localities the subject of the seasons and catch can best be described separately for the several regions in which pound nets are employed:—

Detour to St. Ignace and Mackinaw City to Hammond Bay.—Along this stretch of shore, embracing a portion of each peninsula, the nets are set sometime during May. In the vicinity of Detour they are generally removed about July 1, but it apparently scarcely pays to leave them in after June 1. Further west and on the south shore there is usually good fishing until August, when the twine is taken up, tarred and repaired and reset in September, although some of the fishermen do not fish again until the following spring. The nets fished in the fall are left in until some time in November.

In those pounds which are set early there is often a good catch of wall-eyed pike about the beginning of May. The heaviest runs of whitefish occur during May and June and there are sometimes fair catches in July, after which this species gradually diminishes. With the exception of the pounds in Potagannissing Bay, there is a small but continuous run of trout until September, but in that and the following month good runs occur; fewer are obtained in November than at any other time. In August and September there are usually good runs of wall-eyed pike, and a few are taken throughout the entire fishing season. Grass pike and sturgeon are caught principally in the warmer months. In the order of their abundance the several species rank about as follows: whitefish, trout, wall-eyed pike, grass pike, sturgeon, suckers, black bass and perch. The whitefish represent at least three-fifths of the total catch, and many of them are so small as to make their capture a menace to the fishery.

Hammond Bay to Alabaster.—In this region the practice varies; at some places the season is continuous from spring to fall, at others the pounds are fished from about May 15 to July 15, and from September 1 to between November 15 and 25, while at still others only the fall season obtains.

In the spring the pounds catch whitefish, trout, wall-eyed pike, herring, sturgeon, suckers, etc. The best fishing is in the fall, when about the same species are caught. Good lifts of wall-eyed pike are made during September, and from that month to November the best whitefish catches are obtained. The herring are taken principally late in the fall, and in those pounds which are fished throughout the season, most of the trout are caught in the spring.

Saginaw Bay.—Here the pound netting is done during spring and fall only. During July and August the shoal waters become warm and most of the fish leave for deeper and cooler parts of the lake. In the spring the nets nearer the head of the bay are the first to be set, while in the fall those near the lake are the first put in order. In an average season most of the pounds are set about April 15 and removed by July 1. In the fall they are set between September 1 and 25 and are finally removed about November 25.

The spring fishery is principally for wall-eyed pike and herring. Most of the herring are caught during May, and after June 1 they practically disappear until fall. The wall-eyed pike generally run most abundantly from about May 20 to June 20.

The catch in September consists of a few herring and inferior fish, perch, suckers, etc. The herring come in numbers during October and stay until the nets are removed, constituting the bulk of the fall catch, although a few whitefish and lake trout are usually caught in the pounds near the mouth of the bay.

Saginaw Bay to St. Clair River.—In the spring the pound net season begins about April 15 and ends about July 15. In the fall it lasts from September 1 to December 10.

In the vicinity of Port Huron there is an important fishery for the sturgeon. It is by far the most valuable species, but herring and wall-eyed pike are of some importance, and few perch and suckers are also caught. The spring fishery over the northern portions of this shore is not very profitable.

The herring are caught in great numbers everywhere during the fall, and in the places more remote from the St. Clair River the profits of the fishermen are derived almost entirely from this species. A few whitefish, trout and pickerel are also taken.

St. Clair River to Goderich.—Stake driving commences about May 1 and the twine is usually in place about May 15. The nets are removed for repairs during August, and are usually out of the water from 2 to 6 weeks, during August and the first half of September. Owing to the exposure of this shore many of the nets are not fished after November 1.

In the spring the sturgeon is the most important species, but wall-eyed pike, herring and a few perch are also caught. During May whitefish are taken in the nets farthest from the St. Clair River. The sturgeon are obtained principally during June. During the summer the fishery is not very profitable, and in the fall the herring is the only fish of importance.

Saginaw River.—It is impossible in this connection to distinguish between the pound nets and the fyke nets or "gobblers." Pound nets were first introduced into the river about 1870. The first fyke nets were provided with wings instead of leaders, but proving less profitable than the pounds they were but little used. About 1880 the present type of fyke net was introduced, and was found to be equal to the pound net in efficiency. It is similar to the pound net, except that the pot is made of the same pattern as in the Lake Erie fyke net.

In 1885 there were about 120 pound nets and 425 fyke nets, a total of 545 pieces of fixed apparatus. In 1890 the statistics show a great reduction in the number of fykes; the fishermen state that the number was about equal to that in 1894, when it was estimated that there were 300 nets all told, of which 80 were above Saginaw City. There was supposed to be about the same number of each kind. In view of the uncertainty of the returns for this river it is impossible to make comparisons, but there has probably been a reduction since 1885.

The nets are allowed by law to extend from each shore a distance equal to one-third the width of the stream. The leaders are from 5 to 9 rods long, with a 5 or 6-inch mesh, and the heart is 40 to 50 feet long, with a 4-inch mesh. The pots of the pounds vary from 14 to 18 feet square, but many of them are 14 feet by 18 feet. Their depth varies from 12 to 16 feet, in accordance with the depth of the water. The pots of the fyke nets are usually about 20 feet long, and, like the corresponding portion of the pounds, have a mesh ranging from 2½ to 3 inches.

The catch consists of about equal numbers of perch and suckers and a much smaller number of wall-eyed pike taken in this connection are of very small size. The following represents the catch of the principal species:—

Suckers.....	279,691 lbs.
Perch	272,347 "
Wall-eyed pike.....	24,823 "
Catfish and bullheads.....	21,134 "

Interference with navigation.—In most parts of Lake Huron there is little complaint of the interference to vessels by the pound nets, as the latter are remote from the usual courses of navigation, and the water deepens too rapidly to permit of their extension far from shore. In Saginaw Bay and the southern part of the lake, near the St. Clair River, there is some complaint, and in the former region gaps are left for the passage of vessels through the longer strings. At Port Huron and Sarnia the pound net fishermen complain that their nets are injured by boats, sand scows and rafts.

SEINES.

Seines were first used on the United States side of the lake about 1841, and were introduced into other localities soon afterwards. In most places the seine fishery

from various causes proved unprofitable and difficult, and Sagnaw Bay appears to have been the only place in which it became at all considerable. Prior to about 1880 there were a number of seines in operation in the vicinity of Bay Port, Saganin River, Pine River and other localities in the vicinity, but the time mentioned the more profitable method of fishing with pound nets became so general that there was no longer room nor inducement to haul the seines.

Port Huron is the only place where seines are fished at the present time, one having been employed in 1894. The catch was reported as consisting of 23,000 pounds of sturgeon and 30,000 pounds of wall-eyed pike.

From 1860 to 1894 seines were the only form of apparatus employed in the fishery between Sarnia and Point Harris. In the latter year they were prohibited by the Canadian government and licenses for pound nets were issued to the fishermen in their stead. Although the fishermen opposed the innovation, they are now satisfied with the change, a year's experience having demonstrated that more fish can be taken in the pounds than in seines. The seines were 75 to 80 rods long, the mesh measuring $2\frac{1}{2}$ inches in the bunt and 5 inches in the wings. In the spring the season was usually from about May 25 to July 1, the catch consisting principally of sturgeon and wall-eyed pike. The fall season was between September 15 and November 20, the only species taken in considerable quantities being the herring. The objectionable feature of this fishery was the capture of considerable numbers of small wall-eyed pike. It was for this reason that the Canadian authorities prohibited the seines, but it is doubtful if the pounds are much preferable in this respect.

In the early history of the fishery, when seines were used between Southampton and Cape Hurd, considerable numbers of whitefish were caught upon the spawning grounds during the fall, and it is generally considered that the damage thus caused was considerable.

OTHER METHODS.

The use of hooks and lines and of spears is not extensive in Lake Huron. Trout and cutfish are the only species taken by the former method and wall-eyed pike, perch and suckers by the latter. There is some sport fishing for lake trout and black bass, but there appears to be no conflict between the sportsmen and the commercial fishermen.

SUMMARY OF CONDITIONS.

From a study of the facts set forth above we have arrived at the following conclusions:—

There has been a vast decrease in the abundance of the whitefish in Lake Huron, and this decrease has continued unchecked to the present time, the same being due to a complication of circumstances. The location of the most extensive fishery for this species has varied from time to time, and it is significant that during any given period of which we have knowledge, the region of the greatest fishery, whether by gill nets or pound nets, has been the region of greatest decrease.

It is impossible to say whether or not the amount of apparatus alone, unaccompanied by other abuses, would have induced the decrease noted. There is no doubt that considerable harm is done by the capture of small whitefish in the pounds, and perhaps to some extent in the gill nets fished ostensibly for menominees. Along the north shore on both sides of the boundary line the catch of small whitefish of inferior value to the fishermen, but of vast consequence to the fishery, is an evil of the pound net fishery which requires correction.

A considerable proportion of all the whitefish taken in the lake are caught during the spawning time, when they are close inshore and readily accessible, and the facility with which they may be taken at such times is probably, to some extent, responsible for their decrease. The discharge of saw-dust into the water of streams

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tributary to the lake and adjacent to whitefish grounds, and the more recent practice of rafting logs from Canada to the United States has, no doubt, had its effect on the whitefish. The bark dislodged by the churning and grinding of the logs in bad weather has caused in places a more or less dense mass of matter upon the bottom, which not only renders the spawning grounds unsuitable for the deposit of eggs, but must also destroy a considerable proportion of the bottom life upon which the whitefish depends for food.

There seems to be no basis for the theory, sometimes advanced, that the decrease in the whitefish has been due to an increase in the lake trout and wall-eyed pike. It is impossible to determine whether there was any increase in either of those predaceous species before 1885, but in both there has probably been a slight decrease since the year mentioned, notwithstanding which the falling off in the whitefish has been unchecked.

Next to the whitefish the sturgeon has shown the most important falling off. This has been very large since the beginning of the fishery and on the Michigan side of the lake it has continued to the present time. On the Canadian shore, in the vicinity of Sarnia, the catch of sturgeon was fairly well maintained from the beginning of the fishery in 1880 until 1894. During that period it was carried entirely on by means of seines, but in the year last mentioned pound nets were substituted and, if the history of the fishery elsewhere is to be repeated here, we should expect a decrease henceforward. There is no doubt that throughout the Great Lakes region the decrease of the sturgeon is due chiefly to the pound net fishery, aided by the practice of catching small individuals which are sold for half price and tersely called "halves" by the fishermen.

During the period for which we were able to acquire information there appears to have been but little decrease in the trout. The large shoal-water variety caught in the fall has apparently fallen off to some extent, but the deep-water form exists in apparently undiminished numbers. The immunity of this species from the effects of the various agencies which have decimated the whitefish is, no doubt, due to its habits and distribution. It is less gregarious than the whitefish, and, instead of being confined to the coastal-platform, it has a lake-wide distribution and an apparently wide individual range of movement. It apparently seeks its food at all depths and finds it in considerable variety and is, therefore, not much affected by the pollution of the bottom. Although the gill net fishery for this species is quite extensive, we have failed to note any serious effect upon its abundance. Young fish are sometimes caught in the gill nets, but as they usually become entangled by the teeth no remedy suggests itself.

Concerning the wall-eyed pike we have been unable to arrive at a satisfactory conclusion. The behaviour of this species is so erratic that the question of an increase or a decrease is difficult to establish with any degree of certainty, but we are inclined to believe that there has been some decrease in its abundance since 1885. It is caught principally in pound nets in Saginaw Bay and the southern end of the lake where very large numbers of the young are obtained at times. The same difficulty occurs in Lake Erie, under which heading the subject is considered at some length.

Taking the entire lake into consideration there is no evidence of any falling off in the herring. There are no abuses connected especially with this fishery.

RECOMMENDATIONS.

Pound nets.—A reduction in the number of pound nets in some places, especially in the northern part of the lake and probably also in Saginaw Bay, is called for.

The recommendations made under pound nets in Lake Erie with respect to the length of leaders, the separation of individual nets in the strings by gaps, and their distance apart are considered to be applicable also to Lake Huron. It is recommended that in Saginaw Bay not more than six pound nets be allowed in a string, and elsewhere in the lake not more than three.

North of a line drawn from North Point, Mich., to Clark Point, Ont., the mesh in the cribs of all pound nets should measure not less than four inches in extension, after shrinkage, and south of said line, not less than $2\frac{1}{2}$ inches. This would provide for the use of only a large mesh in that part of the lake where the whitefish is the most important species and where the young are being captured in undue quantities, and would permit the taking of herring and other small species in those localities where they are now mainly fished for. In the latter case the proposed mesh is also larger than the one now employed, and would, perhaps, serve to liberate a certain proportion of the undersized wall-eyed pike, which are at present a conspicuous feature of the catch.

The use of pound nets during November should be prohibited north of the line above defined, in order to provide a close season for whitefish.

All pound net stakes should be removed from the water within thirty days after the close of the fishing season.

Gill nets.—The mesh in all gill nets should measure at least 5 inches in extension, except that nets of $2\frac{1}{2}$ -inch mesh might be allowed to be fished on the Canadian shore between Sable River and Cape Hurd from October 15 to November 1 for the capture of herring, which at that season do not appear to be associated with young whitefish in that locality.

During November it would be expedient to prohibit fishing by any gill net having a smaller mesh than 6 inches, which would serve in large measure to protect the spawning whitefish.

The use of any gill net within $\frac{1}{2}$ mile of any fixed net should be prohibited. The mesh in gill nets used for the capture of sturgeon should measure at least 11 inches in extension.

Fyke nets.—The mesh in the bag of fyke nets should measure at least $2\frac{1}{2}$ inches in extension. The number of these nets should be restricted in accordance with the capacity or requirements of each region in which they are employed.

Seines.—The dimensions of seines and the size of mesh therein should conform in each instance to the conditions under which they are employed. The mesh should, in all cases, be sufficiently large to permit the escape of undersized fish, and the number of seines as well as the manner of their use should be properly restricted in all places. It should be prohibited to fish seines on or about the spawning grounds, of any of the important fisheries, or in any place where their employment would be unduly harmful.

Naked hooks for sturgeon.—The method of taking sturgeon by means of naked hooks or grapnels should be prohibited.

Spears.—The use of spears for taking fish of any kind should be prohibited.

Sturgeon.—All sturgeon measuring less than 4 feet long, by whatever means taken, should be returned alive to the water.

Pollutions.—The throwing into the water of fish offal, including dead fish taken from the nets, of city garbage and of all other substances deleterious to fish life should be prohibited. Steps should also be taken to prevent injury by the waste from saw-mills and from manufacturing establishments of all kinds both along the shores and in all tributaries containing spawning grounds of important fisheries. It is recommended that in connection with all harbour improvements, and other works of that character, due precaution should be taken in disposing of the material obtained by dredging, etc., to prevent injury to any fishing grounds.

Propagation.—A continuance of the joint efforts to increase the supply of whitefish and lake trout through the agency of artificial propagation is recommended.

GEORGIAN BAY.

DESCRIPTION OF THE BAY.

Georgian Bay is entirely bounded by Canadian territory, except at the extreme western end of its north channel. From the foot of the bay near Collingwood to the junction of the north channel with the St. Mary's River, it covers a distance of about 225 miles, while its greatest width from the mouth of French River to the junction of the bay with Lake Huron, north of Cove Island, is 54 miles. It is so cut up with islands, especially on its east and north shores and through the north channel, that the extent of its fishing area is difficult to estimate. These islands, numbered by thousands, are of all sizes, from Grand Manitoulin, with a length of 70 miles and a width of 25 miles, to the merest rocks just showing above the surface. The bay proper has an average depth of 25 to 40 fathoms, the greatest depth, about 90 fathoms, being found close offshore in the south-western corner. The water is deepest towards the south shore and shoals gradually towards the north. The deep water mentioned above occupies only a limited area, practically the whole bay being fished. In the north channel the average depth does not exceed 20 fathoms. At certain seasons it is the custom of the fishermen to abandon the mainland stations, and to operate from the islands out in the bay, the principal ones resorted to for this purpose being the Bustards, Squaws and Minks. The extensive fishery carried on from the Duck Islands, situated at the northern end of Lake Huron, is usually associated with those of Manitoulin Island and Georgian Bay. The principal mainland stations for the southern and eastern part of the bay are Wiarton, Owen Sound, Collingwood, Penetanguishene, Waubashene and Byng Inlet; and for the northern part, Killarney, Round Island, Gore Bay and Thessalon.

IMPORTANT FISHES.

Six species of fishes are enumerated in the statistics of Georgian Bay, the variations in the relative annual catch of these at five years intervals having been as follows:—

	1870.	1875.	1880.	1885.	1890.	1894.
1.....	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout
2.....	Trout	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout	Whitefish, Trout
3.....	Wall-eyed pike.	Herring...	Herring...	Sturgeon	Wall-eyed pike.	Wall-eyed pike.
4.....			Wall-eyed pike.	Wall-eyed pike.	Sturgeon	Sturgeon.
5.....				Herring...	Herring...	Grass pike
6.....				Grass pike	Grass pike	Herring.

Whitefish.—The records of the Canadian inland fisheries show that a larger catch of whitefish has been made in the Georgian Bay than in all the Canadian waters of the remainder of the great lakes system combined. The yield has been more constant, and, in spite of the extent of the fishery and the appliances used, it is only within the last few years that any decided decrease has been shown. The catch reached its zenith about 1890; it remained about the same up to 1892, though the amount of gear used had more than doubled. Since this last date it has fallen off steadily, though the amount of gear employed has been greatly increased. White-

fish are found all over the Georgian Bay and north channel, and they follow here the same shoreward migrations in the spring and fall that they do in the other inland waters. The fishery begins as soon as the ice is clear of the shores, generally some time in May, earlier or later as the seasons vary. During May and June the gill nets are set not far off shore in shoal water, but as the season advances the fish move into deeper water or farther offshore. The offshore fishing lasts through July and August and part of September, when the shoreward movement of the fish begins, culminating with the close of the season at the end of October. Up to 1892 the catch of whitefish was usually greater than that of trout, but since that date the whitefish have fallen off, and now more trout are being taken. Many spawning grounds are known to the fishermen among the islands and on the off-shore reefs, the principal ones being about the Western Islands and Bustards and on the reefs off the Squaws. The spawning season extends through the month of November.

Trout.—The trout have certainly not decreased to anything like the same extent as the whitefish. Fishing for this species begins about the same time as for the whitefish, but during the spring and early summer the proportion of trout taken is not so great, while after September the most of the fish taken in the gill nets are trout. Fishermen claim to recognize two classes of trout, one a smaller fish caught on the offshore reefs and in the deeper water about them, the other a much larger fish always taken inshore. Trout are not as abundant in the north channel as they are south of Grand Manitoulin Islands and around the Ducks. The spawning season is everywhere said to be considerably earlier than that of the whitefish, and the offshore trout are reported to spawn earlier than the larger fish found inshore. The spawning grounds are distributed all round the shores of the bay among the islands, and on the outer reefs and shoals. Trout are mostly caught in the gill nets, comparatively few being taken in the pounds.

Wall-eyed pike.—When seines were used, the best fishing for wall-eyed pike was made early in the spring, near the mouths of the rivers; in many places this seining was done under the ice, the fish being then on their way into the rivers to spawn. An extensive fishery of this kind was carried on at the head of Nottawasaga Bay and at the Waubashene. At the present time wall-eyed pike are mostly taken in the pounds in the north channel. These fish are rarely caught in the gill nets when fished offshore, but during the spring and fall, and particularly in the latter season, when the gill nets are being used inshore, a considerable proportion of wall-eyed pike is obtained by that means. The wall-eyed pike are distributed all along the coast, but are most abundant in the neighbourhood of the large rivers which discharge into the bay and north channel. Large catches are known to have been made in the trap nets which have been fished illegally among the islands on the eastern shore of the bay. The pounds fished in the north channel take a fair amount, but not so many are caught in those set off the south shore of Manitoulin Island and the Ducks. The spawning season of this species is said to be during the latter part of April and the early part of May. As pound nets are not fished in the Georgian Bay proper, and the attention of the fishermen is almost entirely paid to the trout and whitefish, there is really no very extensive fishery made for the wall-eyed pike over the greater part of the bay, and no decrease in the abundance of this fish has been detected.

Lake herring.—This species is abundant all over the Georgian Bay region, but as, until quite recently, there has been no falling off in the fishery for trout and whitefish, no inducement existed to engage in the herring fishery, particularly as the herring taken in the bay are small in size, not averaging over a quarter of a pound each in weight. No fishing is done for them in the spring or summer, at which seasons they are not found inshore, but they are caught to a small extent by means of gill nets in October and November, when they are in shoal water.

Sturgeon.—In the early days sturgeon were very abundant in the Georgian Bay and north channel, particularly in the shoaler bays into which certain of the large rivers discharge. Here as elsewhere they had no commercial value and

were simply rolled out of the seines and destroyed as a nuisance. At present they are mostly taken at the head of Nottawasaga Bay and at Grande Batterie. As far as we have been able to ascertain, the only methods by which they have been taken in this region is by means of seines and pounds, gill nets and set-lines never having been tried, certainly not on any large scale. The returns indicate that a great decrease in their abundance has occurred, as shown by the three annual catches given in the following table:—

1885	478,000 lbs.
1890	127,050 "
1894	90,265 "

Black bass.—This game fish is not by any means abundant in the Georgian Bay region. A good deal of sport fishing is said to be carried on by summer visitors about Waubashene, and among the islands north of that place, but elsewhere on the northern shores of the bay and along the north channel, bass are seldom or never seen. They have never been taken in the nets fished for whitefish and trout, and form no part whatever of the commercial catch.

CAUSES OF DECREASE.

For many years the Georgian Bay has been one of the principal sources of the market supply of whitefish, as already stated, and the fishery has here been carried on with more vigour and enterprise than anywhere else in Canadian fresh waters. Whitefish and trout are found over the entire area of the bay and north channel, and furnish almost the sole object of the fishery. Prior to 1885 the amount of apparatus employed had not varied much for about 20 years, and the output has been constant. As, however, the whitefish supply from other sources began to fail, increased efforts were put forth by the fishermen of the bay to meet the demand, fishing tugs were more largely employed and the amount of gill netting was greatly increased. As the result of this, we find that between 1885 and 1890 the quantity of whitefish caught was quadrupled. The fishing kept up for a couple of years after 1890, the amount of gear being steadily increased, but here, as elsewhere, the thing had been overdone, and in 1893 and 1894 we find a sudden drop in the catch. The following table shows the amount of apparatus in use at intervals of five years beginning with 1870, together with the catch of whitefish, trout, herring and wall-eyed pike at the same times:—

Year.	No. of fishing tugs.	No. of boats.	Gill nets, fathoms.	No. of pounds.	Whitefish.	Trout.	Herring.	Wall-eyed pike.
					Lbs.	Lbs.	Lbs.	Lbs.
1870			298,049		990,000	723,000		41,000
1875	6	264	431,174		2,346,800	2,551,400		
1880	9	166	405,619		1,042,000	1,001,800	53,800	
1885	15	253	380,163	62	1,421,160	3,369,860	12,600	10,400
1890	28	236	941,600	29	5,498,800	3,496,240	187,600	353,442
1894	32	345	1,086,715	62	2,509,436	3,583,607	263,400	635,150
								402,610

Reports since received show that the decrease has continued in 1895 and 1896. For several seasons back complaints have been made by all who handle Georgian Bay whitefish at market, that the fish have been undersized. This sudden and alarming decrease in the catch of whitefish has been due mainly to overfishing with gill nets, although the returns show that 1,086,715 fathoms of gill net were licensed in 1894, it is everywhere admitted by the fishermen that much more than that

quantity was being fished. The great bulk of the whitefish is caught in the bay with gill nets, fished by boats which operate from the various stations on the mainland or from the islands, about which the summer fishery is carried on. The nets are supposed to have a $4\frac{1}{2}$ -inch mesh.

That the depletion has been caused by the excessive use of this class of nets is evident from the fact that no other method of fishing for this species has been here employed; and if the whitefish now shipped to market are undersized, as they undoubtedly are, this can only be because the mesh in use is too small. In the north channel pound nets, as well as gill nets, are fished, and the blame for the failure in this particular region must be shared by the two methods. The gill net fishery in the north channel has not been as extensive as in the bay. The decrease there evidently began about 1885 when areas were licensed without regard to the number of pounds fished or the size of their mesh. Fishermen in all parts of the region agree in saying that to the extensive and wasteful fishing by this means then carried on in the north channel, on the south side of Grand Manitoulin and at the Ducks must be attributed the falling off in both whitefish and trout. When this system of licensing areas was abolished the number of pound nets fished was reduced, as is shown by the statistics for 1890 in the above table. The number has, however, been again increased.

As the species taken in these pounds are whitefish, trout, wall-eyed pike and sturgeon, there can be no object in using a small mesh in the pot, such as is required when the catch consists in great proportion of the smaller grades of fishes. We were present at Detour, Michigan, when various parcels of fish from some of these pounds were brought there to be marketed, and can speak of our own knowledge as to the condition of affairs existing. The following table shows the weights of four lots of whitefish:—

Lot No. 1 consisted of 65 fish, weighing 100 pounds.					
"	2	"	74	"	100 "
"	3	"	74	"	100 "
"	4	"	59	"	60 "

The average weight of the fish in the entire shipment was $1\frac{1}{2}$ pounds, but there were a great many weighing only from $\frac{1}{2}$ to $\frac{3}{4}$ pound each. The other species represented were trout and wall-eyed pike.

Most of the Georgian Bay fishermen claim that there has been no decrease in the trout, and the returns do not show that there has been, but a much larger outfit is required to maintain the catch. The trout are taken on the same grounds as the whitefish, and generally with the same nets, though some men use a stronger and larger meshed net. The same complaints are made regarding the trout from the bay as about the whitefish, namely, that they are too small to bear transport and be handled profitably. Large quantities of undersized trout are undoubtedly being sent to market from both the Georgian Bay and north channel, and it is only by the capture of these sizes that the volume of the catch is being kept up. They are obtained to some extent in the pounds, but mainly by the gill nets.

It is well understood that some small trout are always taken in the gill nets, no matter how large the mesh may be, as they get caught by the teeth and become entangled in the net, but the proportion of fish thus taken is always small. In the case of the Georgian Bay, however, the small trout constitute an important part of the supply and are difficult to dispose of, as they invariably reach the market in poor condition. The bulk of these undersized trout are secured in the smaller meshed gill nets, fished for whitefish.

Among the minor causes to which we may attribute the failure in the whitefish and trout is the deposition of bark from the rafts of saw logs which are constantly being towed across the bay and north channel from some of the larger rivers, especially French River and Spanish River, to the milling ports on the Michigan side of Lake Huron. The grinding of the logs against each other in the booms sets free the fine inner bark which settles on the bottom, forming a thick covering. When

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Some of the inshore spawning grounds are said to have suffered from the saw-dust and other mill refuse which has been carried down the streams from the mills; but little injury can have been done in this way, as many of the spawning grounds are offshore or remote from the neighbourhood of the mills, and of late years the regulation prohibiting the letting adrift of this refuse has been well observed. The fishermen seem to have been careful about the disposition of refuse fish and fish offal and have generally landed it on the rocks. As the shores of the bay are not extensively settled other pollutions cannot have occurred.

FISHING METHODS.

General Account.—The principal methods of fishing are by means of pound nets and gill nets. Pound nets are not allowed to be fished east of a line running from Cape Hurd to Spanish River; that is to say, they are only permitted in that part of the north channel west of Spanish River, on the south side of Manitoulin Island west of the line before mentioned, and at the Duck Islands. They are prohibited in the bay proper. This arrangement was made at the request of a large majority of the fishermen of the region. In all 62 pound nets were employed in 1894. Gill nets are fished over all parts of the bay, the quantity licensed in 1894 having been 1,086,715 fathoms, operated from 32 tugs and 345 sail boats. Seines were at one time extensively used in some of the bays and channels and near the mouths of some of the rivers, but they are now prohibited. Fyke nets, although permitted, have never been employed except to a very slight extent. Trap nets, small submerged pounds with a covered pot, are not permitted, but they have been extensively fished by poachers, and whenever found they have been confiscated. The manner in which the bay, particularly along its eastern and northern shores, is cut up with channels, inlets and deep creeks, facilitates the use of these engines and makes it difficult to detect them. Trawl line fishing and hook and line fishing are not practiced.

Gill nets.—The gill nets used in Georgian Bay are similar to the trout and whitefish nets of Lake Huron, and the rigs employed are about the same. The most of them have a $4\frac{1}{2}$ -inch mesh, but a few of 6-inch mesh are fished at certain times for trout only.

The gill net fishery in Georgian Bay began about 1835 or 1838. It was prosecuted from canoes and small boats of not over 14 feet keel, and the man who possessed a half dozen short home-made nets was counted rich. Nothing under a 5-inch mesh was employed; stones were used on the nets for sinkers, and thin strips of cedar for floats. The nets were put out in the evening and taken up in the morning, the sinkers and floats being removed from the nets each time they came ashore.

Most of the catch was whitefish, and all was salted. The traders came around in schooners supplying the fishermen with salt and barrels, and taking the fish in exchange for general supplies. During the period of the civil war in the United States, from 1861 to 1865, there was a great demand for salted fish, and the prices then received were better than ever since. This demand, no doubt, forced the development of the fishery, as by 1868, when the first official report by the Canadian Department of Marine and Fisheries was issued, it seems to have already attained considerable proportions, the returns of that year showing that 451 men engaged in the fishery, with 144,750 fathoms of gill nets, the catch amounting to 1,884,386 pounds of whitefish, 767,400 pounds of trout and 7,800 pounds of wall-eyed pike. Gill nets continued to be, practically, the only method used until 1881, when pounds were introduced in the north channel, although a few seines were occasionally employed.

The following table shows the length of gill nets fished since 1870 at intervals of five years:—

	Fathoms.
1870.....	298,049
1875.....	431,174
1880.....	405,619
1885.....	380,163
1890.....	941,600
1894.....	1,086,715

Between 1870 and 1875, tugs were introduced into the gill net fishery, and their number increased until 32 were employed in 1894. The fishery is prosecuted mainly from Wiarton, Owen Sound, Collingwood, the vicinity of Waubashene and Midland, Killarney and Thessalon. The tugs and boats located at the Duck Islands fish entirely in Lake Huron.

In the summer, after the shore fishery falls off, the tugs from the southern and south-eastern parts of the bay fish at the western islands and the Minks, and around the islands and banks lying north of Parry Sound; and at the same season the fishermen from Killarney and other mainland ports move out to Squaw Island Bank, Grand Bank and Lonely Island.

The fishery for whitefish and trout is carried on simultaneously. From the time the ice leaves, early in May, until July, the nets are set inshore, but during July and August they are moved into deeper water, and upon the banks and around the outlying islands. In September they are again brought closer to shore, where they are used until the beginning of the close season, 1st November. In the spring and summer the catch consists principally of whitefish, but in the fall more trout are caught.

Pound nets.—The pound nets are similar in construction to those used elsewhere in the great lakes. The leaders are mostly short, with the mesh 6 or 7 inches in extension. The cribs are 40 to 50 feet square, and when the fishery first began a mesh of less than 2½ inches was used, but afterwards a uniform 4-inch mesh throughout was adopted. In 1894, the Dominion government voluntarily reduced the size, but the fishermen had not all taken advantage of this privilege at the time of our visit. There appears to have been no good reason for the change, and we consider that its effect will be disastrous to the whitefish.

Pound nets have never been fished extensively in any part of the bay, except the north channel and on the outer side of Grand Manitoulin Island. The latter region is really in Lake Huron, but as the fish caught there are shipped from Wiarton the statistics usually regard this locality in connection with Georgian Bay.

In 1894, 62 pound nets were fished in this region. They were all in stands of one each and were located in the north channel, both on the main shore and on the numerous islands, and also on the southern shore of Grand Manitoulin Island at its western end, and on the neighbouring Duck Islands. The pound net fishery began at the Duck Islands about 1881, and at Indian Island and near Killarney at about the same time. After several years, however, these nets were forbidden in the region east of a line passing from Cape Hurd to Spanish River. The maximum number was reached about 1889, since which time there has been a gradual reduction. This appears to have taken place mostly on the outer side of Grand Manitoulin Island east of the Duck Islands; it is estimated that there were at one time at least 40 pounds between Massiasagua Strait and Providence Bay, where there are now but 9.

The pounds are set as early as possible after the water is free from ice; the time varies with the season, being sometimes in April and sometimes even as late as May 24. The season lasts until November 1. The principal fish taken in this region is the whitefish. It is present during the entire season, but June and July witness the largest catches. Wall-eyed pike also occur throughout the year; if the nets are in early, a good run may be had in the spring, but the best month is

August. Trout are caught in May, June and July, and again from September to the close of the fishery. Several species of suckers, perch, grass pike and a few sturgeon are also taken.

Seines.—Seines were never employed extensively for whitefish as the bottoms to which this species resort for spawning are generally so stony and rough as to prevent the use of this form of apparatus. The small amount of seining which has been carried on was mainly for sturgeon and wall-eyed pike at Wabashene, Nottawasaga Bay and Killarney. The total length of the seines used has been as follows: 1870, 440 fathoms; 1880, 137 fathoms; 1890, 2,466 fathoms. These nets are now prohibited in the bay.

RECOMMENDATIONS.

The principal fisheries in the Georgian Bay and north channel are those for whitefish and lake trout, and as the decrease in the abundance of those species has apparently been due to two causes, over-fishing and the taking of immature fish, two remedies naturally suggest themselves, namely, a reduction in the amount of fishing and such an increase in the size of the mesh employed as will prevent the capture of an undue amount of the undersized fish.

Although it is understood that the present close season during the month of November does not fully cover the spawning season of the trout, yet it is believed, as this species has not decreased to anything like the same extent of the whitefish, that a reduction in the amount of gill netting fished and an increase in the size of the mesh will afford it all the protection now necessary.

In view of the fact that the fishery with pound nets is carried on mainly for whitefish, trout, wall-eyed pike and sturgeon, it is considered important that only a large-sized mesh be allowed in the cribs. As there can be no objection to the capture of wall-eyed pike and coarse fishes in the bays and among the islands. We deem it advisable to allow a limited amount of fishing with trap nets and fyke nets along the eastern shore of the bay.

We would, therefore, recommend as follows:—

1. That the amount of gill netting now used for whitefish and trout be considerably reduced, and that means be taken to insure that not more than the amount licensed be fished by any tug or boat.
2. That the minimum size of gill net mesh fished for whitefish and trout be fixed at 5 inches, extension measure.
3. That the number of pound nets now fished west of the line from Cape Hurd to Spanish River be not increased; that the regulation which prohibits the use of such nets east of that line be continued; and that the minimum size of mesh in the crib of the pounds be fixed at 4 inches.
4. That a limited number of trap nets and fyke nets be licensed to be fished along the eastern and northern shores of the bay between Waubashene and Killarney.
5. That gill nets having a mesh large enough to prevent the capture of individuals less than 4 feet long, and also set lines with baited hooks, be licensed for the catching of sturgeon.
6. That all sturgeon taken under 4 feet in length be returned alive to the water.
7. That the close season during which whitefish and trout shall not be taken shall be the month of November.
8. That herring may be fished for at all seasons with gill nets having a mesh of not less than 2½ inches.

LAKE SUPERIOR.

DESCRIPTION OF THE LAKE.

Lake Superior, the largest of the great lakes, is characterized by its greater depth, the much greater relative extent of its deep water, and its low temperature.

There is a general absence of shoal areas at a distance from the shores, along which, moreover, the water usually deepens rapidly, the slopes being more abrupt, as a rule, on the northern than on the southern side. The fishing grounds are, therefore, chiefly restricted to a comparatively narrow zone around the borders of the lake, the superficial extent of which is less than one-fourth that of the entire lake, and not much more than one-half the fishing area of either Lake Huron or Lake Erie. The physical conditions of Lake Superior are, furthermore, unfavourable to the production of a great variety of fishes, and only a few of the species represented have been at all prolific. There are however, three more or less prominent bays on the northern side of the lake and three on the southern side, in which the conditions are somewhat tempered.

IMPORTANT FISHES.

The most important fishes of Lake Superior are the whitefish (*Coregonus clupeaformis*) and lake trout (*Cristivomer namaycush*). Other species taken for market are the lake herring (*Argyrosomus arctedi*) and one or two related forms, the siscowet (*Cristivomer namaycush siscowet*), wall-eyed pike (*Stizostedion vitreum*) and sturgeon (*Acipenser rubicundus*).

Whitefish.—The whitefish are generally distributed along the borders of the lake, ranging outward into depths of 40 to 50 fathoms, seldom farther, and in some places coming close upon the shore during the spawning season and in the spring.

Throughout the greater part of their range they have given rise to more or less extensive fisheries, although in some regions, as along the Minnesota shore and about Isle Royale, they have always been scarce. This species was the one to which attention was first directed on Lake Superior, and until recently it composed the greater part of the annual catch, but within a few years it had ceded precedence in that respect to the lake trout. The only statistics of the catch for the shores of the United States side of the lake are the following:—

1880	2,257,000 lbs.
1885	4,571,000 "
1890	3,213,000 "
1893	2,010,000 "

Leaving out of consideration the seasonal fluctuations in production, which we have not the means of measuring, the above figures indicate a decreased annual output between 1885 and 1890 of 30 per cent; between 1890 and 1893, of 37 per cent, and between 1885 and 1893, of 56 per cent. This decrease, moreover, was coincident with an increase in the amount of the principal kinds of apparatus employed, and the statistics for 1890 and 1893 were obtained in sufficient detail to show that between those two years the proportionate decrease for pound nets was 57 per cent and for gill nets 64 per cent. The actual decrease has been most marked on the Wisconsin shore, where, between 1885 and 1893, it was enormous, amounting to over 90 per cent. On the Michigan shore, as a whole the production was maintained between 1885 and 1893, but only by the use of a much greater amount of apparatus, equal to 63 per cent in pound nets and 14 per cent in gill nets. On some parts of this shore the figures show an increase, and on other parts a decrease in the output, but the abundance of the fish has apparently everywhere diminished, as is evidenced by the extra efforts required to keep up the catch.

The testimony of all witnesses examined at the principal fishing centres tends positively to corroborate the deductions based upon the statistics, and it also establishes the fact that the fishermen generally are conversant with the changes which have taken place in the status of this product.

The statistics for Canadian waters show a comparatively steady increase in the catch during recent years, coincident with an increase in the amount of apparatus. The evidences of a decrease in the species are not nearly as marked as on the south shore, although the testimony obtained in the Port Arthur region indicated a con-

siderable falling off. The Canadian catch has always been much smaller than that made in the United States, but in 1893 it amounted to 40 per cent of the latter. The quantity of apparatus employed is much larger on the south shore than on the north shore.

Lake trout.—The lake trout are somewhat more evenly distributed than the whitefish, being abundant on the shores of Minnesota and Isle Royale, as well as along most parts of Wisconsin, Michigan and Canada. Their range in depth is approximately the same as that of the whitefish, although extending down to 60 fathoms or slightly more. They do not, however, come abundantly into the shallower water, and in deep water they are replaced by the siscowet, a well-marked inferior variety, which is generally most plentiful in 80 to 100 or 125 fathoms. The lake trout was not sought for, especially during the early period of the fishery, but in recent years it has been greatly in demand, owing partly to the diminishing supply of whitefish. The statistical returns for the United States side of the lake have been as follows:—

1885.....	2,599,000 lbs.
1890.....	2,485,000 "
1893.....	3,061,000 "

In Canadian waters the following annual catches have been made during the past ten years:—

1885.....	911,000 lbs.
1886.....	842,000 "
1887.....	703,000 "
1888.....	971,000 "
1889.....	1,020,000 "
1890.....	692,000 "
1891.....	1,077,000 "
1892.....	1,055,000 "
1893.....	1,128,000 "
1894.....	1,543,000 "

The falling off in the catch in 1890 was coincident with a temporary decrease in the extent of fishing on both sides of the line, and the subsequent increase of production was accompanied by an increase in the amount of apparatus employed. Over 80 per cent of the annual catch in United States waters has been obtained by means of gill nets, the balance in pound nets and by hooks and lines. The statistical returns are not indicative of a decrease in the abundance of the species in Lake Superior considered as a whole, but they show a falling off in the production in some localities, more especially about the Apostle Islands, since 1885, and at Isle Royale, since 1890. According to the testimony of witnesses, however, there has been a general decrease, the extent of which could not be ascertained, in all parts of the lake except at the eastern end, in the region about Whitefish Point and thence to Otter Head on the Canadian shore. In this latter area, moreover, there has been a large increase in the extent of fishing in very recent years, with a corresponding increase in the amount of the catch.

Lake herring.—Although the herring is a common species in most places about the border of the lake, it has never given rise to more than a very moderate fishery, owing mainly to the distance of markets, but in part also to its generally inferior size in these waters. The supply can be in no danger of diminution while the demands upon it remain as small as at present.

Siscowet.—The siscowet, which inhabits a deeper zone of the lake than the whitefish and lake trout, is poorly esteemed in the market on account of its exceeding fatness, and it, therefore, offers little inducement to the fishermen, except in the event of a scarcity of trout. Considerable quantities are sometimes captured, but the supply is undoubtedly sufficient to withstand any drains that may be made upon it under existing circumstances.

Wall-eyed pike.—This species is scarce on nearly all the open shores of the lake, being mainly confined to a few of the bays on both the northern and southern sides, in none of which, however, is it abundant except on a very limited scale. The total catch in 1893 amounted to only 185,000 pounds, or a little more than 2 per cent of the combined weight of all species taken. The principal places where it has been captured are the western part of the Wisconsin shore, Chequamegon Bay and the head of Whitefish Bay on the United States side, and Black Bay and Buchewanaung Bay on the Canadian side. It is more common in some portions of St. Mary's River. There has evidently been a considerable decrease in the abundance of this species, but it has never been the object of a special fishery, having figured mainly as an incidental feature of the pound net catch.

Sturgeon.—The sturgeon, like the wall-eyed pike, are of very limited distribution in Lake Superior, being restricted mainly to a few of the more or less inclosed areas, in some of which they are reported to have been relatively abundant at one time. In the aggregate, however, they have constituted only a very inconspicuous feature of the fishery, and little profit has been derived from them. The total production for United States waters in 1885 was 182,000 pounds; in 1893, 35,000 pounds; showing a decrease of over 80 per cent, coincident with an increase in the number of pound nets, by which means they have chiefly been captured. The Canadian catch for the past ten years has been as follows:—

	Lbs.
1885.	41,000
1886.	41,000
1887.	120,000
1888.	54,000
1889.	71,000
1890.	97,000
1891.	43,000
1892.	49,000
1893.	35,000
1894.	39,000

HISTORY AND METHODS OF THE FISHERY.

Beginning of the fishery.—Commercial fishing was first started in the neighbourhood of Whitefish Point soon after 1860, and by the end of that decade it had been extended to the few important settlements along the southern border of the lake as far as Duluth, all of the principal methods now employed having been introduced by 1870. On the Canadian shores commercial fishing dates from about 1871.

Seines.—Seines were in use prior to 1860 for supplying domestic wants, and in conjunction with gill nets constituted the earliest appliances of the market fishermen. They proved very profitable in the beginning, more especially in the capture of whitefish during their periodical movements into shallow water, but they have been gradually falling into disuse, as the schools no longer approach the shores to the same extent as formerly. They have been employed on the shores of all the counties along the southern side of the lake, but probably most extensively and with greatest effect in Wisconsin, between Duluth and the Apostle Islands. The Minnesota coast is not adapted to their use. The greatest number recorded was forty-three in 1885.

The catch by this means in United States waters is relatively very small, having been equal to only about 2½ per cent of the total catch in 1893. Seines have not been utilized on the Canadian shore since 1874.

Gill nets.—Gill netting is carried on along all the shores of the lake except between Pic Island and Otter Head on the Canadian side. It is prosecuted mainly for the capture of lake trout, whitefish and siscowet, but moderate quantities of

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herring are also taken by this means. The rapid slope of the bottom in most places necessarily restricts the fishery to within a comparatively few miles of the land, and on some sections of the coast the nets are mainly set close along the shore. For the most part relatively small rigs are used, but there are a number of large tugs with headquarters at some of the principal fishing centres, such as Duluth, the Apostle Islands, Marquette, Grand Marais, Whitefish Point and Port Arthur. On the Canadian shore at the eastern end of the lake, between Whitefish Bay and Otter Head, the fishery is also conducted on an extensive scale under one management, but chiefly by means of sail boats. The herring nets are mostly employed off Marquette and Duluth.

There has been only a comparatively slight increase in the total quantity of gill nets fished in United States waters since 1885, when that fishery reached nearly its greatest development, but considerable fluctuations in the quantity have occurred in the intervening years. In Canadian waters the maximum was attained in 1884, since which time there has been, as a whole, a general decrease in the amount of gill netting employed along the north shore, but an increase at the eastern end with considerable fluctuations from year to year. The statistical returns for 1893 give the length of gill nets in use that year as follows:—

	State or District.	Length in fathoms.	Total length in fathoms.
United States waters.....	Minnesota	90,682	
	Wisconsin	139,653	
	Michigan	542,961	
Canadian waters.....	North Shore.....	27,000	772,696
	East End.....	86,790	113,790
			886,486

The Canadian regulations provide that the mesh of gill nets shall measure at least $4\frac{1}{2}$ inches in extension. There are no laws respecting this matter which are applicable to United States waters, but the customary sizes of mesh there employed are between $4\frac{1}{2}$ and $4\frac{3}{4}$ inches, although a 4-inch mesh is sometimes seen. Larger sizes up to $5\frac{1}{2}$ and 6 inches, are also occasionally used on both sides of the line, especially for the trout.

Pound nets.—Although Lake Superior does not present the advantages for pound net fishing possessed by Lakes Erie and Huron, it is carried on at intervals along the entire southern border, but the Minnesota coast is not adapted to this purpose and has never had more than 4 pounds at any one time, all of which have been located near the Canadian boundary. This method of fishing has been most extensively prosecuted on the Wisconsin coast, including the Apostle Islands and Chequamegon Bay, on the east side of Keweenaw Peninsula, and in the vicinity of Whitefish Point. In 1879 the total number of nets on the south shore was about 50. In 1885 it had increased to 230, and in 1893 to 276. The principal increase in recent years has been about Whitefish Point and in Chequamegon Bay.

Pound nets were introduced in Canadian waters, in the vicinity of Port Arthur, in 1878, but during the first decade their number on the north shore never exceeded 8. In 1891 it increased suddenly to 53, but by 1894 it had fallen off to 29. At the eastern end of the lake, between Whitefish Bay and Otter Head, the first of these nets were built in 1883. The maximum number in this region, 21, was reached in 1891, but in 1894 there were only 16 in use.

The mesh in the cribs of the pound nets when new is supposed to measure at least 4 inches on the Canadian side, while on the United States side it ranges from $3\frac{1}{2}$ to 4 inches. Considerable shrinkage takes place after tarring and submersion in the water.

The relative importance of the gill net and pound net fisheries on Lake Superior is indicated approximately by the returns of the catch in United States waters for 1893, which show 61 per cent of the total output to have been obtained by means of the former apparatus and 28 per cent by means of the latter.

Other methods.—Set lines are employed to some extent for taking trout and siscowet, more especially on the coast of Minnesota and about Isle Royale and the Keweenaw Peninsula. Beginning about 1890, this method of fishing has been increasing at the western end of the lake, owing to the fact that the outfit is much less expensive than in the case of pounds and gill nets, and the profits on a small scale are relatively greater. The number of hooks so used in 1893 was about 25,000, the catch amounting to about 8 per cent of the total catch of trout and siscowet in United States waters.

Fyke nets are practically unknown on Lake Superior, and there are probably very few places where they could be employed to advantage. Eleven were enumerated in the statistics for the south shore in 1893, but none have been recorded in any of the returns for Canada. The Indians make use of dip nets for taking whitefish at the base of the rapids in the St. Mary's River at Sault Ste. Marie, but this fishery is of little moment. Sport fishing for brook trout, black bass, etc., is carried on in parts of the same river, but there is very slight inducement for angling anywhere in the waters of Lake Superior.

EXTENT AND CAUSES OF DECREASE.

Of the six species which are the principal objects of the fisheries on Lake Superior, a decrease has evidently taken place in the supply of whitefish, lake trout, wall-eyed pike and sturgeon, while the herring and siscowet appear to be as abundant now as ever. The change has been most serious with respect to the whitefish, formerly composing the greater part of the catch; it has been least noticeable in the case of the lake trout, and of relatively minor importance with the wall-eyed pike and sturgeon.

Our inquiries have failed to demonstrate that agencies foreign to the fisheries have been responsible to an appreciable extent for this decrease. The depth and the low temperature of the water, together with the sparsely settled condition of the shores, preclude the influence of ordinary pollutions as well as of traffic except in a few restricted localities. Logging has sometimes caused injury to the nets, and has frequently interfered with the operation of the seines and pounds, but there is no evidence to show that the fish themselves have been harmed thereby. The refuse from saw-mills appears to have had only a local influence at the most, affecting, possibly, some of the inshore feeding and spawning grounds, but no proof was obtained of its extensive distribution on the bottom of the lake at any time, and for some years past its retention on the shore has been suitably provided for.

It has been impossible to learn to what extent the offal produced in cleaning fish was deposited in the water during the early period of the fishery, but the practice is now widely deprecated and it is seldom followed, except in connection with winter fishing when the offal may be left upon the ice, although much of it is then said to be devoured by the dogs and scavenger birds. It is not considered probable, however, that any marked injury has been caused by this means in recent years, if at any time.

The evidence obtained from all sources tends to substantiate the view that at least the bulk of the decrease observed has resulted from overfishing under some or all of the conditions and practices which have prevailed, but, owing in large part to our imperfect knowledge of the habits of the fishes in this region, it has been impossible to estimate satisfactorily the relative importance of the different factors concerned.

At the inception of the fishery, Lake Superior was especially noteworthy for the quantity of whitefish, mainly of large size, which came into the shoal waters, chiefly in the spring and fall. This circumstance led to the multiplication

of seines and of shallow water gill nets, by means of which extraordinary catches could be made with little effort. The introduction of pound nets came next, followed by the extension of gill net operations into deeper water, and these two methods are the ones now principally pursued, the shoreward movement of the large fish and the advantages for seining having greatly diminished. Much of the decrease of the whitefish is now commonly laid to the early seining, and while this claim may be justifiable, in some degree, it is a fact that the falling off in the supply has been most apparent during perhaps the past decade. It has also been manifested in the catch obtained by each of the several methods employed, thereby indicating its distribution to all depths of water although not necessarily explaining the means by which it has actually been effected.

The only appliances used for the capture of whitefish have been seines, pounds and gill nets. Seines were formerly employed extensively during the spawning season, and they may have been chiefly instrumental in diminishing the supply of the larger grade of fish, which approached the shores mainly in the spring and fall, but it is probable that the pound nets were also largely, and the gill nets slightly, responsible for that result. Seine fishing in the late fall has been practically abandoned for some time, having become unprofitable, but it has been continued to a greater or less extent at other seasons, especially in a few localities where a small class of fish resorts to the shallow waters in large schools. The catches there made are said to consist principally of inferior sizes, mostly below the standard recognized by the fresh markets, those disposed of being salted by the fishermen and shipped at their risk. The dealers are not inclined to handle this grade of goods and by their attitude in the matter have done much to break up the practice. Notwithstanding the discouragements in that respect, however, this seining has often been persistently continued, and failing to secure a market for the catch, large quantities of the young fish have been left upon the beaches to decay. The destruction by this means seems to have been relatively great, but the evidence fails to show that seining has everywhere been as pernicious in its effects as here described, the greatest amount of damage being indicated for the western part of the lake along the south shore. We have been unable to confirm the reported capture of large amounts of young whitefish by the herring seines, the use of which has been exceedingly limited.

Although the number of pound nets fished in Lake Superior is much smaller than in either Lake Erie or Lake Huron, this method of fishing has been of relatively great importance, considering the comparatively narrow fishing zone along the margins of the lake, fully one-half the total catch of whitefish in recent years having probably been obtained by this means. The fall season, however, is generally cut short by inclement weather, and while all fishing is prohibited in Canadian waters during November, on the southern side of the lake it has been customary to remove the pounds before that month to prevent their destruction by storms. A few may be left in at times on the Wisconsin shore until about the middle of November, but it is evident that in the capture of spawning whitefish the pound nets can have figured only to a very limited extent.

It is generally admitted, however, that many small and undersized whitefish are taken in these nets, the evidence also indicating that this happens most commonly in the western part of the lake as is the case with the seines. The smallest size desirable for the fresh trade is about $1\frac{1}{2}$ pounds. The dealers generally would prefer to handle nothing under that size, and the profits would be relatively greater to the fishermen if only the larger fish were marketed. No practicable method of determining either the average size of the whitefish taken in the pounds or the quantity obtained below any stated size has been presented, nor has it been possible to ascertain by actual observation the sizes of fish that may be able to pass through the several grades of mesh employed, and opinions differ widely in regard to these matters. In Canadian waters the law provides that the mesh of pound net cribs shall measure at least 4 inches; on the United States side it ranges from $3\frac{1}{2}$ to 4 inches; but these sizes are for the new twine which shrinks considerably during use. Moreover, as is well known, many fish that might readily pass through any given mesh,

if they attempted so to do, may be held and captured therein whenever a large mass of fish is taken. The use of a large mesh is, therefore, not an absolute guarantee against the capture of small fish, but there is no doubt that it provides for the escape of so large a proportion of them as to demonstrate the importance of regulating the mesh on the basis of the minimum size of whitefish proper to be marketed. As the pounds are not fished for herring in this lake, only a single standard of mesh is called for, and the case is greatly simplified as compared with Lake Erie and Lake Huron. If the minimum size of marketable whitefish is placed at $1\frac{1}{2}$ pounds, the mesh should be regulated accordingly. It is said that large quantities weighing not over half pound apiece are now captured in the pounds in some places, and of fish from that size up to $1\frac{1}{2}$ pounds, the annual catch seems to be relatively very great. On other parts of the shore they are reported to be taken rarely under 1 to $1\frac{1}{2}$ pounds, but observations are lacking to show to what extent the abundance of these smaller sizes varies with respect to locality. It is probable, however, that the depth of water in which the pound nets are set, as well as the character of their surroundings, greatly influence this result, the young occurring most abundantly in the shallower water, while the deeper nets and those on bold shores secure a larger average size.

It is the prevailing opinion that, even excluding the large grade of whitefish, the average size of this species has become smaller than was formerly the case, and this decrease in size is shown more markedly in the pound net catch than in that made by the gill nets, as the latter tend to sort out or exclude the smaller fish. That is to say, the size averages larger in the gill net than in the pound net catch, and the latter form of apparatus is to be considered as most detrimental in catching small whitefish.

In Canadian waters the gill net mesh is supposed to measure not less than $4\frac{1}{2}$ inches, but on the United States side of the line it ranges down to 4 inches for both whitefish and lake trout nets. The maximum sizes are from $5\frac{1}{2}$ to 6 inches, but these are used only in a few localities and to a limited extent. The sizes now generally employed in United States waters are from $4\frac{1}{2}$ to $4\frac{3}{4}$ inches, the use of the smallest mentioned being restricted mainly to the extreme eastern part of the lake, on the coast of Michigan.

In the $4\frac{1}{2}$ -inch mesh the smallest sizes of whitefish said to be taken weigh from $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds, and these figures agree with the results of limited observations by the commission. With respect to a $4\frac{3}{4}$ -inch mesh, the estimates place the minimum sizes taken at from about $1\frac{3}{4}$ to 2 pounds, all fish under a fresh marketable size thereby escaping through it. For this reason it would be preferable to employ nothing smaller than $4\frac{1}{2}$ inches. Formerly the average size of the mesh employed was larger than at present, and the reduction has been brought about in consequence of the diminished average size of the fish. This fact alone tends to show that gill netting has had at least some detrimental effect upon the supply of whitefish.

In the herring gill nets, which are used to a limited extent in many parts of the lake, the mesh ranges in size from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. In some places the herring are found practically alone, but in others the young of both whitefish and trout may be associated and captured with them, but there is no proof that the quantity of those two species so taken is appreciable.

All fishing is supposed to be suspended in Canadian waters during November, but from the principal stations on the south shore, gill netting is carried on to a considerable extent during a part or all of that month. The November catch is said to consist less of whitefish than of trout, but it nevertheless includes a large proportion of the former. Whether the nets are set extensively upon their spawning grounds or interfere greatly with their habits at that period it has been impossible to learn, but quantities of the spawning fish are secured in some places. Gill nets were among the appliances formerly employed for the capture of the large whitefish as they came upon the beaches in the spring and fall, but that fishery has mainly been destroyed. The whitefish are reported to spawn chiefly on reefs and sand banks near the shore, in depths of 4 to 8 fathoms, but such localities are often too much exposed to permit of fishing upon them during the severe weather which

generally prevails at that season. The spawning period is said to extend principally from about November 1 to 20.

As the catch of lake trout by pound nets and hooks and lines combined is less than one-quarter that obtained by gill nets, it is natural to expect that the cause of any decrease observed will be found mainly in connection with the method of fishing last mentioned. It is possible that the gill net fishery for the trout has been carried on too extensively in some localities, and that too many fish are being thus removed from the water annually in those places.

The spawning season of the trout begins in the latter part of September, and continues through most of October. During this period also the best trout fishing occurs, and large quantities of the spawning fish are secured. They are obtained mostly in the gill nets, but to some extent also in the pounds, although the majority of the latter seem to be removed by the beginning or during the early part of the spawning season. To prohibit fishing at this time or even during any considerable part of it would be equivalent to abolishing the fall fishery.

Smaller trout than whitefish are captured by the gill nets, owing to the fact that they often become caught by the teeth or otherwise entangled by the twine. The amount taken in this manner, however, can scarcely be large enough to cause any appreciable amount of injury, nor is there any way in which the occurrence can be avoided, as it has no relation to the size of the mesh. Aside from this, the minimum sizes of trout taken in the gill nets do not appear to differ materially from those of the whitefish already given; and, as with the latter species, the prevailing opinion seems to be that the average size of the trout has decreased in many places, which fact has also influenced the recent use of smaller-meshed nets than formerly. In some localities, however, more especially on the northern shores of the lake, the trout run relatively large, and larger-meshed nets are more commonly employed. The fresh markets would prefer to receive no trout under 2 pounds in weight, and where the gill net mesh is at least $4\frac{1}{2}$ inches, smaller sizes are said rarely to be obtained. The $4\frac{1}{2}$ -inch mesh will take them down to $1\frac{1}{2}$ pounds, if not to $1\frac{1}{4}$ pounds. Small trout are also captured in the herring gill nets employed along the Minnesota shores, but probably only in limited numbers.

More small trout, relatively, are reported to be taken in the pound nets than in the gill nets, the same as with the whitefish, but the total pound net catch of trout is comparatively light. The hook and line fishery for trout has never been extensive, although it has been increasing somewhat rapidly during the past few years. The fish taken by this means are said to average large, and it was not learned that the method presents any features to which objection can be raised at the present time.

The decrease in the abundance of wall-eyed pike and sturgeon can be charged only to the pound nets, by which means they have been captured almost exclusively.

SUMMARY OF CONDITIONS.

Owing to its small area of shallow water, Lake Superior ranks below each of the other Great Lakes, except Lake Ontario, in the extent and importance of its fishery resources. The number of market fishes which occur in sufficient abundance to provide for extensive operations is practically limited to four, the whitefish, lake trout, siscowet and herring. Of these only the whitefish and trout have been at all conspicuous in the catch, the demand for the siscowet and herring being comparatively small and not likely to increase materially in the immediate future. The only other market species now meriting attention are the wall-eyed pike and sturgeon, neither of which is of more than local interest.

The whitefish has suffered a heavy decrease, which began to be noticed several years back and has been felt on most parts of the coast, but chiefly in United States waters. The catch of lake trout, however, has apparently been maintained as a whole, although the supply seems to have diminished to a greater or less extent in some regions. The character of its distribution and habits insures for this species

a greater degree of natural protection than is possessed by the whitefish, and renders its depletion more difficult although not impossible. Both the wall-eyed pike and sturgeon have decreased greatly in abundance.

The principal fishing methods which have been followed in Lake Superior, enumerated in the order of their importance, are the use of gill nets, pound nets and seines. Set lines have not been extensively employed until within a comparatively few years.

As no evidence has been obtained to show that outside agencies have materially affected the fishing interests, we must look to the practices of the fishermen themselves for an explanation of at least the more important changes in the abundance of fishes which have taken place. The details of this subject have been discussed under the preceding heading. Seines have been partly concerned in the removal of the schools of large and spawning whitefish, and in the destruction of considerable quantities of young whitefish, both of which have been in the habit of coming upon the shores in immense numbers at certain seasons. This class of nets, however, is now used much less extensively than formerly.

The number of pound nets employed has never seemed excessive, considering the wide extent of the lake; the intervals between them have generally been reasonable and they have seldom been placed in strings. The practices in this respect have been influenced by the narrowness of the platform, and the tendency of the whitefish to approach the shores so closely. These circumstances, however, have increased the relative effectiveness of the pounds, and have, apparently, made them an important factor in causing the decrease of whitefish, of which fully one-half the catch in recent years seems to have been secured by this means. These nets are but little use during the spawning season of the whitefish, but their number has probably been greater than was advisable in some especially favoured places, and the small mesh employed has resulted in the destruction of many undersized fish.

There has also been a marked decrease in the proportionate catch of whitefish by the gill nets, although no large quantity of the young can have been removed through the medium of these nets. Excessive fishing by this method has probably affected the supply of whitefish, and as the larger sizes have been caught off an effort has been made to maintain the catch by introducing a successively smaller mesh, until now the latter has reached a limit where whitefish and trout below the fresh market standard are taken to some extent. Gill netting is carried on during the spawning season of the whitefish in United States waters, and during the spawning season of the lake trout on both sides of the line. No positive evidence has been presented to show that any appreciable amount of young whitefish is captured in the herring gill nets.

As the main part of the catch of lake trout is obtained by means of gill nets, it is natural to look to that fishing method for the principal cause of any decrease in this species which may have taken place. The catch of wall-eyed pike and sturgeon, however, has been made chiefly in the pound nets.

RECOMMENDATIONS.

The remedial measures suggested for Lake Superior are as follows:—

1. In all localities where there is evidence of overfishing by the pound nets the number of the latter should be suitably restricted. These nets should be separated by an interval of at least one mile, and they should not be allowed to extend more than one-third the distance across any channel or passageway.
2. Wherever young whitefish abound and may be captured by the pound nets in appreciable quantities, the use of such nets should be prohibited either entirely or during such periods as the young of that species may be so present.
3. The mesh in the cribs of all pound nets should measure at least 4 inches in extension, when in use.
4. It would seem that the extent of gill net fishing for whitefish and trout had reached, if not passed, a safe limitation, and that some restriction should be placed

upon the quantity of gill nets to be fished hereafter. Further observations, however, are required to establish a satisfactory basis for action in this matter.

5. The mesh in gill nets employed for the capture of the common whitefish and the lake trout should measure not less than $4\frac{1}{2}$ inches, and we consider that a 5-inch mesh would be preferable.

6. The herring gill nets and those used for the smaller varieties of whitefish require a smaller mesh than the above, but the conditions under which such nets may be employed should be explicitly defined.

7. No restrictions appear to be called for at present in respect to the herring gill nets, except that their use should be prohibited wherever young whitefish would be taken in them.

8. The number of seines employed at present is relatively small, and it should not be allowed to increase beyond a safe limitation.

9. The mesh in whitefish seines should measure not less than $3\frac{1}{2}$ inches in the bunt and $4\frac{1}{2}$ inches in the wings.

10. The use of all kinds of seines should be prohibited wherever the capture of young whitefish is involved, either entirely or during the seasons when the young are present.

11. It is considered that it would be beneficial to institute a close season covering the spawning period of the whitefish, during which no fishing for the species should be permitted.

12. All sturgeon measuring less than four feet long, which may be taken by any means, should be returned alive to the water.

13. It may be found advisable to establish local regulations for the protection of the wall-eyed pike in places where they occur, but no information that would be serviceable in that respect has been collected.

14. The throwing into the water of fish offal, and of all other deleterious substances in places where it would be harmful to fish life should be prohibited.

15. Joint efforts for the increase of the supply of both the whitefish and the lake trout by means of artificial propagation are recommended.

LAKE OF THE WOODS, RAINY LAKE AND RAINY RIVER.

DESCRIPTION OF THE WATERS.

The greater part of the boundary line between the state of Minnesota and the Dominion of Canada passes through the series of lakes and rivers beginning at the low divide near Lake Superior and terminating at the west in Lake of the Woods. While the shore lines of this water system have been sufficiently well laid out for general purposes, its hydrography has not been studied and a detailed description of its characteristics in that respect is impossible at the present time. The region is still very sparsely settled, and until within a few years only slight attention had been given to its fishery resources, now forming the basis of one of its most conspicuous industries. Lake of the Woods is, by far, the most important, as it is also much the largest, of these bodies of water. It is connected with Rainy Lake through its principal affluent, Rainy River. Both of these lakes are very irregular in shape with many ramifications, the greater part of each being located in Canadian territory. Rainy River, about 80 miles in length, has a winding course, with some swift water and several rapids, but is navigable for small steamers. Up to the time of our visit in 1894 only a very limited amount of fishing had been attempted on either Rainy Lake or Rainy River, and we, therefore, restricted our inquiries chiefly to Lake of the Woods, where the extensive operations then in progress made it most desirable that the conditions should be understood.

The total length of Lake of the Woods in a direct line north and south, from Rat Portage to the mouth of Rainy River, is about 60 miles. East and west its ramifications are said to extend nearly 100 miles, but its water area is very much

less than those figures signify, owing to the innumerable islands which it contains and its exceedingly irregular outline. In fact, except in its southern part, relatively large expanses of water surface are rare, the land areas greatly preponderating. These differences between the northern and southern parts of the lake are significant of topographical and geological differences also. At the south the shores are low and sandy, with some marshy tracts, while toward the north the shores and islands are mostly rocky and relatively high, giving rise to many picturesque features. The water is correspondingly deep with rough bottom toward the north, and shallow and smooth toward the south, the character of the fisheries in the upper and lower parts of the lake being greatly influenced by this diversity of conditions.

The outlet of Lake of the Woods is Winnipeg River which flows into the lake of the same name, whence the drainage is into Hudson's Bay. Rat Portage, having a population of about 2,000, is situated at the foot of Lake of the Woods of which it is the principal port, being also a divisional station on the Canadian Pacific Railway. All of the exports from the lake now pass this way. Two smaller towns close by Rat Portage complete the list of settlements on the lake, outside of which the only inhabitants are a few squatters, the fishermen connected with the several fishing stations during the summer, and a considerable number of Indians.

The international boundary line in this region is diverted northward from the 49th parallel in such manner as to give to the United States most of the southwestern portion of the lake, including a piece of the mainland which is isolated from the southern border of the lake by a strip of shore belonging to Manitoba. Two small, but important islands, Oak Island and Garden or Cornfield Island, are also situated on the United States side of the boundary.

The principal fisheries are now located in the southern, open part of the lake, commonly known as the Big Traverse, and in the vicinity of Oak Island. A line of soundings made by us across the Big Traverse, from Long Point to Garden Island, developed a maximum depth of 39 feet with depths of 30 to 35 feet within a couple of miles of either shore. The bottom consists of soft mud except near the shores where it becomes sandy. The main part of the Big Traverse has an average width of about 15 to 18 miles, and a length of about 30 miles, but narrower extensions from it toward the east and north retain, in part at least, the same general characteristics. During the summer months, owing to the slight depths, its stagnant condition and high temperature, the water in the Big Traverse and adjacent thereto becomes so highly charged with several varieties of microscopic plants as to give it an intensely green colour which reaches from the surface to a depth of several feet. This feature is indicative of the organic richness of the water in this part of the lake, the basis of its abundant fish supply. These same conditions, however, are the cause of much annoyance to the fishermen through the rapid destruction of their nets by rotting.

FISH AND FISHERIES.

Fishes.—The principal market fishes of Lake of the Woods are the sturgeon (*Acipenser rubicundus*), whitefish (*Coregonus labradoricus* and probably *clupeiformis*), wall-eyed pike (*Stizostedion vitreum*), pike (*Lucius lucius*), and lake trout (*Cristivomer mamaycush*). A few other species, such as the calico bass (*Pomoxis sparoides*), suckers, buffalo, bullheads, and yellow perch (*Perca flavescens*), are also some times sent to market in small quantities. The sturgeon constitutes much the most important feature of the fisheries, which, except for the presence of this species in the lake in great abundance, would probably not this time have attained more than local significance. As a fact, however, there can be a few, if any, sheets of water of its size in the world which give a greater annual yield of fishery products. The caviar is the product chiefly sought, although the sturgeon meat finds ready sale, and the sounds are also preserved.

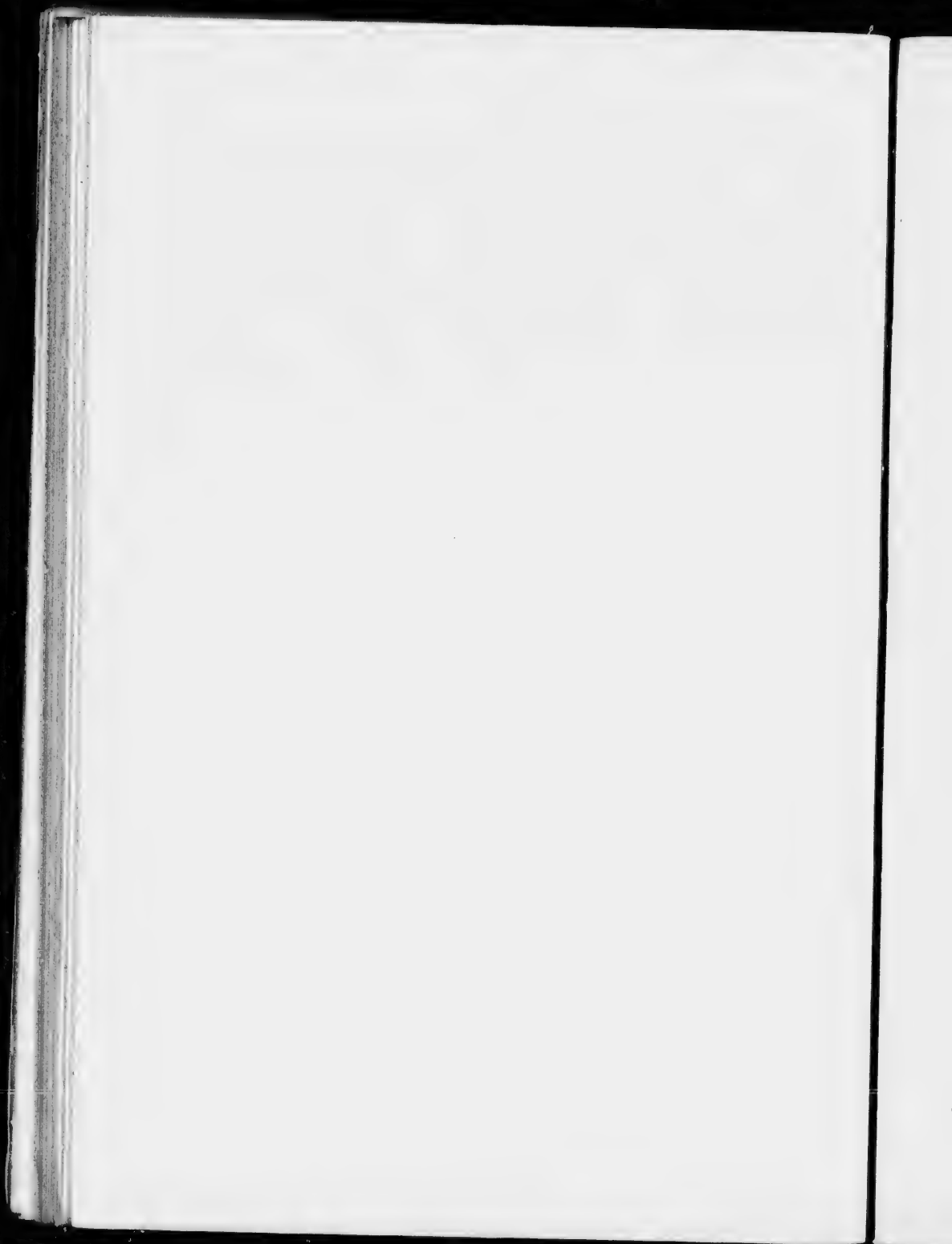
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The relative importance of the several species is shown by the following statistics of the amounts shipped through Rat Portage during 1894 and 1895. The figures are given separately for the catch on each side of the boundary line:

CATCH FOR 1894.

Species.	United States Waters.	Canadian Waters.	Total.
	Lbs.	Lbs.	Lbs.
Sturgeon.....	1,059,267	162,760	1,222,027
Whitefish.....	411,018	449,280	860,298
Wall-eyed Pike.....	405,104	62,010	467,114
Pike.....	231,474	.....	231,474
Lake Trout.....	.....	12,873	12,873
Miscellaneous.....	96,520	62,310	158,830
Totals.....	2,203,883	749,233	2,952,616

CATCH FOR 1895.

Species.	United States Waters.	Canadian Waters.	Total.
	Lbs.	Lbs.	Lbs.
Sturgeon.....	1,143,072	779,114	1,922,188
Whitefish.....	280,563	713,226	993,789
Wall-eyed pike.....	473,776	254,608	728,384
Pike.....	125,861	83,348	209,209
Lake trout.....	.....	10,287	10,287
Miscellaneous.....	40,915	99,291	140,206
Totals.....	2,064,187	1,839,874	4,004,061

Although the weight of the catch of "scale fish," so-called, exceeds that of the sturgeon, the value of the latter, including the caviar and sounds, is the greater. The exports of caviar amounting to 173,270 pounds in 1894, and 186,699 pounds in 1895; of sturgeon sounds, to 4,063 pounds in 1894, and 5,315 pounds in 1895.

Fishing methods and localities.—The United States catch is derived from a limited area of water, while the Canadian fisheries are carried on in both the southern and northern parts of the lake, the fishing methods being totally unlike in those two sections. We were unable to obtain figures to show what proportion of the Canadian catch was made in each, but the sturgeon fishery is limited to the southern, while the lake trout probably come almost entirely from the northern part.

In the northern parts of the lake market fishing is chiefly restricted to the use of gill nets, which are employed mainly in Big Stone Bay, Clearwater Bay, Yellow Girl Bay and Whitefish Bay, in depths of a few fathoms to over 25 fathoms. In 1894, only about 25 licenses were issued by the Canadian government, each giving

authority for the use of 1,500 fathoms of such netting, but it cannot be said that all of these privileges were utilized. The legal size of the mesh is 5 inches, out larger sizes, up to 6 inches, are also employed. The gill net catch consists of whitefish, wall-eyed pike, pike and lake trout, together with some waste species. One of the large shippers estimates that probably only about one quarter the quantity of whitefish and a smaller proportion of the wall-eyed pike exported from the lake are taken in the gill net fishery. The fisheries in the northern parts of the lake are, therefore, conducted practically on a very limited scale, and as the areas now resorted to by the gill netters are rather far removed from the boundary line they can well be considered to have no immediate relations with the region adjacent to the latter.

The great bulk of the fishing is carried on in the more open, shallow waters composing the southern or upper portion of the lake, where pound nets are the only appliances employed in connection with the market trade. The growth of this industry has been marvellous, prompted by the exceeding richness of the supply of sturgeon, and facilitated by the very favourable natural conditions which here prevail.

Pound nets.—Pound nets were first introduced in Lake of the Woods in 1887, in which year two such nets were located on the southern shore near Winter Road River. The same pounds were in place in 1888, and two additional ones were built at Garden Island, making four in all. In 1889, the number on Garden Island was increased to six; in 1890 there were about twelve pounds on that island, and five on the south shore. The following year the south shore had about fifteen, and Garden Island about twelve. In 1892, the number on the south shore had been increased to 27; the number on Garden Island is not recorded, but fishing was commenced that year at Oak Island, near the mouth of North-west Angle Inlet. In 1893 there were 30 pounds on the south shore, 10 at Oak Island, and about 7 at Garden Island, a total of 47 in those localities, all in United States territory. The first pounds on the Canadian side of the line, two in number, were built in 1893 on the south shore east of the mouth of Rainy River.

In 1894, the year of our visit, the total number of pounds had increased to 160, of which 146 were in United States, and 14 in Canadian waters, as follows: In the former, 96 on the south shore between the mouth of Rainy River and a point just to the west of Long Point, covering a distance of about 19 miles; 7 on Garden Island; 13 on the mainland opposite Garden Island; and 5 on Oak Island and the adjacent mainland. In the latter, 12 on the south shore, within a distance of about 10 miles to the eastward of the mouth of Rainy River; and 2 at Skiff Island at the eastern end of Little Traverse.

During the first part of the season of 1895, 98 additional pounds were fished, making a total of 258, of which 188 were in United States waters and 70 in Canadian waters. The United States nets were located as follows: 126 on the south shore between the mouth of Rainy River and the international boundary line at the west; 7 on Garden Island and 15 on the opposite mainland; and 40 on Oak Island and the adjacent mainland. The Canadian nets had the following distribution: 34 on the south shore, west of Rainy River; 25 on Bigby Island and adjacent islands; 5 on Big Island; and 6 on Buffalo Point at the western end of the Big Traverse. The addition of several more nets was contemplated during the fall of 1895.

This rate of increase is unprecedented in the history of pound net fishing anywhere in North America.

The construction of the pounds is the same as on the great lakes. Each consists of a crib, tunnel, heart, and leader, all made of cotton netting supported on stakes driven into the bottom. They may be placed separately or in strings of 2 to 5 nets, but seldom more than 3 are joined together in this way. The average length of the leaders is about 50 rods, while the cribs are about 30 feet square. Reckoning on an interval of 10 rods between the inner end of the leader and the shore, which is probably about an average, single pounds would extend a distance of about 1,000 feet, and strings of the same 1,845, 2,700, 3,555, and 4,410 feet respectively, according as they contained 2, 3, 4, or 5 cribs.

By Canadian regulations $4\frac{1}{2}$ inches is the minimum size of mesh that can be used in the cribs. On the United States side of the line there are no restrictions in this regard, the customary size employed being $3\frac{1}{2}$ inches. These dimensions are for the netting as it comes from the factory, but it shrinks considerably after tarring. The size of mesh is of little importance as concerns the capture of sturgeon, but it has greater significance in respect to the whitefish, wall-eyed pike, etc., as elsewhere explained.

The pound net season on Lake of the Woods is relatively short. They begin to set the nets between the middle and latter part of May or as soon as the ice permits, some time being required to complete this task where many pounds are being operated under one management. It has been the custom on the part of most fishermen to continue this early fishing only until the first part of July, but occasionally until the 10th or 15th of that month, when, on account of the condition of the fish and the rapid rotting of the nets during mid-summer, the latter are removed for a period of four to six or eight weeks or until some time between the middle and last of August. The fall season lasts through September and October. Some take out their nets as early as the 1st of October, and few attempt to fish into November as stormy weather or the formation of ice may suddenly destroy their gear at any time during that month. A few pounds have generally been kept in position during the summer months, with perhaps an interval of a week or two to provide for the cleaning and retarring of the nets, and there seems to be an inclination to increase the amount of fishing at that season.

Sturgeon, basis of fishery.—As before stated the great abundance of sturgeon has been the incentive for the rapid growth of the pound net fishery on Lake of the Woods. Had there been no sturgeon in these waters pound nets would undoubtedly not have been introduced up to the present time, and should the supply of that species ever become depleted it may safely be predicted that these nets will mostly, if not entirely, disappear, as the scale fish do not seem to be sufficiently abundant to support an extensive fishery alone in view of the inconvenient means of marketing the catch. The welfare of the fishing interests of this lake depends, therefore, chiefly on maintaining the stock of sturgeon on essentially its present basis of productiveness. The quantity of sturgeon inhabiting the lake is assuredly very great, indicating unusually favourable conditions for the reproduction and sustenance of the species, but in all cases there is a certain limit beyond which the resources of nature cannot be drawn upon with impunity.

The sturgeon are all dressed before shipment, the head, tail, fins and entrails being removed. The average weight of 675 sturgeon shipped in this condition during the period of our visit was found to be very nearly 25 pounds. On this basis the total exports for the season of 1895 would represent 76,887 sturgeon, an exceedingly large output considering the limited area of the lake.

Distribution and habits of the sturgeon.—It has been impossible to obtain much information respecting the distribution of the sturgeon in this lake, their movements, spawning habits, etc. They are observed to some extent among the islands in the northern part of the lake, but there is nothing to show that the bulk of the fish ever travel that way, unless it be during the winter months, and it is generally conceded that they remain chiefly in the more shallow southern areas during most of the year. The evidence points to Rainy River as furnishing important spawning grounds, but the sturgeon may also resort extensively to other streams, although the number of the latter is very small. Reliable observations regarding the time of spawning are likewise lacking. The uncertainty concerning that question is increased among the fishermen by the fact that according to their view the eggs utilized as caviar are in about the same condition in both the spring (May and June) and fall, while during mid-summer (July and August) they appear less mature, are smaller, and have less commercial value. The majority of the fishermen place the spawning season between the latter part of May and the early part of July, the most reliable testimony rather favouring the last two or three weeks in June, and the first week or two of July, but there may be more or less fluctuation in the time. A smaller proportion

of caviar is said to be obtained from the same number of fish during the early part of the season at Garden and Oak Islands than along the south shore, giving rise to the impression that the ripe fish resort mainly to the latter region at that period. It is significant that we could not learn of the capture of sturgeon with ripe running eggs on any of the fishing shores. In none of the thousand and more sturgeon which we carefully examined between August 6th and 10th, 1894, were the eggs ripe or even sufficiently large and mature to be classed as of first quality.

The spring fishing is said to begin earliest in the vicinity of the mouth of Rainy river, the fish moving westward from that point along the Minnesota shore. At Garden Island they do not commence to take them until a week or two later, and they arrive about Oak Island somewhat later still. These facts are considered by some of the fishermen to indicate that the bulk of the sturgeon make their appearance in the spring from Rainy River, and distribute themselves to different parts of the lake from its mouth, but there are no other data supporting this supposition.

Decrease of the sturgeon.—Up to the summer of 1895, there had been no marked indication of a general decrease in the abundance of the sturgeon, so far as we are able to judge from the figures obtainable. This is as might be expected considering that the fishery had then been carried on extensively for only about three years. Some of the fishermen of longest experience on the lake, however, were firmly convinced that a falling off was already apparent, and with few exceptions all of the fishermen interviewed agreed that the supply cannot long withstand the heavy drains being made upon it. The settlers along Rainy river, as far up as Fort Francis, furthermore complain that while at one time they had no difficulty in obtaining during the spring all the sturgeon required for home consumption, the number has been so much reduced since the introduction of pound nets in the lake that they are now becoming scarce.

The history of all regions in which sturgeon fishing has been actively prosecuted shows that the supply of that species may readily be depleted, a result which has come to be regarded as inevitable wherever the stock is sufficient to warrant operations on a large scale. So universally has this been the case that we cannot doubt the early extermination of this product in Lake of the Woods for all practical purposes unless stringent measures are introduced at once to prevent or at least delay it.

CONCLUSIONS AND RECOMMENDATIONS.

International interests on Lake of the Woods are concerned chiefly with the preservation of the sturgeon. Although the pound-net catch of scale fish is comparatively large and important, especially at certain seasons, should the capture of sturgeon become unprofitable at any time that method of fishing would probably be mostly, if not entirely, abandoned, and little less be done thereafter in waters closely adjacent to the boundary line. As both the scale fish and sturgeon, however, are taken together and under the same conditions, their preservation should and can be arranged for on a common basis.

The most effectual measure of relief and one which we strongly urge to be carried out is a restriction on the extent of fishing, which undoubtedly already far exceeds a safe limitation. It is impossible to determine positively the maximum number of pound nets which could be fished without danger of depleting the supply, as the latter is an uncertain and fluctuating quantity, and the matter will, therefore, have to be settled arbitrarily; but we are convinced that within the small area to which this kind of fishing is confined the total number of pound nets in use should not exceed 150, to be divided between the two countries in proportion to the extent of shore line belonging to each. Even this number we regard as too large to insure the ultimate preservation of the sturgeon, but we have been constrained not to reduce it still farther in view of the fact that the industry has already been firmly established on so large a basis.

Besides the limitation upon the number of pound nets to be employed, we would recommend that not over two such nets be allowed in any one string; that the

loaders to the same be not over 50 rods long each; that the inner end of any pound net or pound net string be set in not less than 10 feet of water, and that the outer end of the same extent not over one mile from the shore; and that no pounds be fished within one mile of the mouth of any stream which the sturgeon are known to enter. The object of such provisions is to insure as much freedom of movement for the sturgeon as possible, both during and subsequent to the spawning run.

We also consider it advisable that no gill net or trawl line fishing be permitted in the pound net region, or south of a line extending due east from American Point, at the mouth of North-west Angle Inlet, to the peninsula, except the use of gill nets by the Indians for supplying their own needs.

While a close time covering the spawning season of the sturgeon could not fail to be beneficial, in order to be effective it would require to begin at such a date and to be continued for so long a time as practically to interfere with the entire spring and early summer fishery, the most profitable in the year. A close season is, however, suggested for the wall-eyed pike and whitefish by restricting the pound net season to the period beginning May 15 and terminating October 31, which is essentially in accordance with the present custom.

Protection should be afforded the young sturgeon by requiring the return to the water alive of all individuals taken in the nets which measure less than 4 feet long. At present they are retained when as small as about $3\frac{1}{2}$ feet, the ordinary maximum size being $5\frac{1}{2}$ to 6 feet. No caviar is said to be obtained from sturgeon under 4 feet long, and none of those containing caviar landed during our visit were less than $4\frac{1}{2}$ feet.

The capture of small whitefish, wall-eyed pike, lake trout, etc., should be restricted by regulating the size of mesh, which should measure not less than $4\frac{1}{2}$ inches in pound nets and 5 inches in gill nets.

No fish offal, garbage, saw-mill waste or other polluting agencies should be thrown or allowed to pass into the waters of the lake.

Fishing for sturgeon in Rainy River, except for domestic use, should be prohibited.

Further inquiries require to be made in Rainy Lake and the more eastern waters of the system before deciding upon the measures necessary to protect their fishery resources.

COLUMBIA RIVER.

The Columbia River rises in the south-eastern part of British Columbia, some of its tributary branches being only a few miles distant from the headwaters of streams which discharge into the Fraser River. It crosses the international boundary line near the north-eastern corner of the state of Washington, and for the rest of its course to the sea flows through United States territory. It is joined a short distance north of the boundary line by the Pend d'Oreille, one of its most important tributaries. We had no opportunity of visiting the headwaters of the Columbia, and heard but little of its fishing capabilities.

All of the species of salmon which belong to the Pacific coast occur in the lower waters of the Columbia; but the hump-back and dog salmon enter the river in comparatively small numbers and do not ascend far. Silver salmon ascend as far as the Snake River, although they are not fished for above the Dalles. The quinnat, sockeye and steelhead are found as far up as the headwaters of the Snake River in Idaho. In the Columbia proper the quinnat are not found above Kettle Falls, although these falls do not constitute an impassable barrier to the passage of salmon; they are from 12 to 15 feet high and in certain stages of the water some salmon do get past. Recent investigations have failed to discover that quinnat salmon ever entered the Pend d'Oreille; there is also no positive evidence that the sockeye is found in this part of the Columbia basin. The steelhead is taken occasionally at the mouth of the Pend d'Oreille, and possibly at other places north of the international boundary, but definite information upon the matter is lacking. There never has been any commercial fishing in the Columbia River above Kettle Falls, and it is not at all

likely that any ever will be established. Under these circumstances, it would seem that there is nothing connected with the Columbia River fisheries which calls for joint recommendations.

WATERS CONTIGUOUS TO THE BOUNDARY LINE BETWEEN BRITISH COLUMBIA AND THE STATE OF WASHINGTON.

DESCRIPTION OF THE WATERS.

Physical features.—The western coast, adjacent to the international boundary line between Canada and the United States, is characterized by a nearly land-locked body of salt water, elongate in shape and extending in a general direction north-west and south-east, a distance of over 200 miles. At the southern end, this body of water penetrates for some 50 miles or more into the state of Washington, while its central and northern portions lie between Vancouver Island on the west, and Washington and the mainland of British Columbia on the east. In some parts, it presents many irregularities as to outline, being much constricted in places, and contains numerous islands which occupy the greatest relative area south of the boundary line. It communicates with the sea by means of two passageways, of which, by far, the larger as well as the shorter one is the Strait of Juan de Fuca, opening on the west. At the northern end begins a series of narrow passages or straits, connecting it with the ocean at the upper end of Vancouver Island.

The northern part of this inclosed sea is known as the Gulf or Strait of Georgia, the southern part as Puget Sound—Washington Sound, a name seldom used locally, intervening. It receives many fresh water streams, but only one of large size, the Fraser River, which rises on the western slope of the Rocky Mountains in the neighbourhood of Yellowhead Pass, and lies wholly within the territory of British Columbia. Its total length is about 740 miles.

The international boundary line, coinciding with the 49th parallel of latitude, strikes the Gulf of Georgia only a few miles south of the mouth of the Fraser River, between it and Point Roberts, and passes thence to the westward of the San Juan Islands, and through the centre of the Strait of Fuca.

Fishery resources.—The waters of this region afford a great variety and abundance of important fishes, of both exclusively marine and anadromous species. The ordinary sea fisheries, however, have been developed only to a limited extent, and with respect to only a few species such, as the halibut, herring and dog fish, and further study must be made before passing upon their condition and requirements.

The important anadromous fishes are several species of salmon and the sturgeon. The latter is now fished for extensively only on the Fraser River, but is taken incidentally in the trap nets and by other means on the coast of Washington, more especially at Point Roberts. As a valuable food product, it is deserving of protection, but it is doubtful if joint action regarding it is necessary at the present time, as there is no incentive to its capture in United States waters. The traps at Point Roberts, moreover, are not set during the period when the species is supposed to be making its spawning run, and a close season is thus provided without the aid of legislation.

International interests.—The most important fishery problems for international consideration in this region, and the only ones which appear now to demand urgent attention, are presented by the salmon fishery, which has already attained a remarkable development, and is still rapidly increasing. This industry has been conducted longest on the Fraser River, where it is also carried on upon much the larger scale. The international character of the subject is determined by the fact that certain bodies of the fish on their way from the sea to their spawning grounds pass successively through the waters of both countries and are fished for on both sides of the boundary line during the progress of this movement.

THE SALMONIDÆ.

General account.—Six species of salmon are here recognized by the fishermen namely, the saw-qui or blue-back salmon (*Oncorhynchus nerka*), called locally "sock eye," the quinnat or chinook salmon (*O. tshawytscha*), humpback salmon (*O. gorbusha*), silver salmon (*O. kisutch*), dog salmon (*O. keta*), and the steelhead (*Salmo gairdneri*). The sockeye is most in demand for canning purposes, in connection with which industry the bulk of the salmon caught in this region is now utilized.

All of the species except the sockeye resort to numerous streams tributary to the Gulf of Georgia and Puget Sound for the purpose of spawning, and in the course of their movements they, therefore, become distributed over the greater part of these inland waters, thus affording opportunities for fishing in widely separated localities. The spawning grounds of the sockeye, on the contrary, seem to be chiefly confined to the Fraser River, toward which the greater part of the entire run, after entering through the Strait of Fuca, is immediately directed. It thus traverses a comparatively well-defined course, outside of which extensive fisheries for the species have not been prosecuted.

Sockeye or blue-back salmon.—This species is known exclusively as the "sock-eye" salmon to the fishermen of the Puget Sound and Fraser River region. It is the species most preferred and chiefly used there for canning purposes, on account of the depth and stability of its colour, the firmness of its flesh, etc. Within the area of its distribution it appears to be generally more constant and reliable in its movements than most of the other forms, and beginning to run at a comparatively early date, it affords a considerable fishery so far in advance of the spawning period as to insure an excellent quantity of fish.

The sockeye, as well as the other salmon, which frequent the Gulf of Georgia and Puget Sound, are supposed to enter from the ocean almost entirely through the Strait of Fuca. Some sockeye are said to make use of the inland passage at the northern end of Vancouver Island, but it is claimed that the schools which make their appearance from that direction proceed no farther south than the meeting place of the tides near the southern entrance to Seymour Narrows, their destination being the small rivers which empty along the adjacent shores.

So far as we have been able to ascertain, the sockeye are first observed abundantly in the Strait of Fuca in the vicinity of Becher Bay, a short distance to the westward of Victoria. Between there and Race Rocks they are fished for to a slight extent. Proceeding farther eastward their general tendency is toward the north. A part of the fish turn immediately in that direction, moving up through the Canal de Haro, past San Juan and Stuart Islands, some apparently continuing through the wider channel into the Gulf of Georgia, while others make use of the narrower passes, of which Active or Plumper's Pass has been especially mentioned by those acquainted with the regions. Still other schools pass to the south of San Juan and Lopez Islands, skirting their shores in part, and proceeding up through Rosario Strait. These, to some extent at least, approach Lummi Island and parts of the mainland to the north as far as Boundary Bay which they enter, and thence move around Point Roberts on their way to the Fraser River. A few sockeye are said to enter the bays along the mainland east of the San Juan Islands, and small numbers are reported to be taken in Skagit Bay and in the vicinity of Seattle, but from the evidence obtained it seems likely that large bodies of the species practically avoid the southern part of Puget Sound and the northern part of the Gulf of Georgia. It is, therefore, found abundantly only in the channels and open waters leading from the Strait of Fuca to the mouth of the Fraser River and in places closely adjacent thereto.

The reason for this restricted distribution is explained by the fact that the Fraser seems to be the only river in this region to which the sockeye resorts extensively, and from the evidence at hand we are led to conclude that the species depends mostly on that river for its spawning grounds and hence for perpetuating the main supply on which the market fishery is chiefly based. Small runs enter Lake Wash-

ington at Seattle, and also ascend the Skagit River and possibly other neighbouring streams, but, according to the testimony presented, their total amount is relatively inconsiderable.

The principal fisheries for the sockeye are carried on in the Fraser river and in the Gulf of Georgia, both off the mouth of that river and around Point Roberts. Other important fisheries on a smaller scale are located at the northern end of Lummi Island and at the southern end of San Juan Island. Small quantities are also taken at several other places, more especially by the Indians.

At the commencement of the seasonal movement the fish are reported to appear successively at Becher Bay and the San Juan Islands, before reaching the Fraser river, and the progress of succeeding large schools or bodies has been noticed in the same order, but observations respecting the rate of travel are exceedingly imperfect, although it is said that an interval of anywhere from 5 days to 2 weeks may elapse between their appearance at Becher Bay and at the mouth of the Fraser River. In some of the fishing places they seem to linger for a time, while they pass by others without stopping. Large numbers may remain for a week or 10 days in the discoloured water off the mouth of the river, where a large part of the cannery supplies has been obtained during the past few years.

The sockeye may begin to ascend the Fraser River in the last part of June or the very first part of July, but they are not looked for in sufficient numbers to start fishing before the 10th of the latter month, and it may be still later before operations can profitably be commenced. As a rule, however, the season is expected to open about July 10, and the fish to be running as heavily as they will by July 20. The big runs seldom continue much, if any, beyond August 20, and the entire movement closes in the early part of September at the latest. These dates fluctuate, however, and sometimes very markedly, from year to year, dependent upon seasonal conditions. Two or three distinct periods in the movements of the fish are recognized by the fishermen both on the river and at Point Roberts, but they are separated only by short intervals of poor fishing.

There does not appear to be much difference in the time of arrival of the fish at Point Roberts and at the Fraser River mouth, but there is lack of satisfactory evidence respecting this subject. The time consumed in ascending the tidal part of the river is discussed below in connection with the subject of drift net fishing.

It is claimed by the fishermen that a regular periodicity occurs in respect to the abundance of the sockeye salmon, arranged in cycles of 4 years. Every fourth year, as a rule, this species is said to appear in greatest abundance, followed by 3 years of successively smaller runs, although the grouping is considered to be more properly 2 good years followed by 2 poor ones. While there is a marked fluctuation in this respect in different years, the statistics of the catch fail to show that it takes place with the regularity described.

From such evidence as could be obtained, it seems probable that the sockeye spawns throughout practically the entire length of the Fraser River system, from its lowest to its highest tributaries. The earliest runs are said to work furthest up stream, while some of the later ones at least enter such low down tributaries as the Pitt and Harrison Rivers, both of which have large lake areas. It is probable that this species resorts to the inlets of the lakes for spawning purposes. The spawning season is chiefly the month of October, but it may begin in the latter part of September and continues more or less into November.

No authentic information respecting the extent of mortality of this species after accomplishing its reproductive function could be obtained in regard to the Fraser River, although enormous quantities of dead ones are observed each year in the tributary streams containing its spawning grounds. Investigations made on the Columbia River, however, prove that none of those at least which reach the upper waters return again to the sea, and it is not unlikely that this strange fatality extends to all parts of the river system.

On the Fraser River the general weight of the sockeye is said to be between 7 and 8 pounds, but they sometimes run as small as 6 pounds, and individuals weighing as high as 10 pounds are occasionally taken.

The catch of sockeye made both in the outside waters and in the Fraser River is used almost exclusively for canning purposes. The local demand is very limited and only relatively small amounts are shipped fresh to eastern markets.

We have not been able to obtain any evidence of a decrease in the abundance of the sockeye salmon since fishing operations were commenced in this region.

Quinnat salmon.—The quinnat, chinook, tyee or spring salmon are present in this region to a greater or less extent during nearly the entire year, if not at all times, and have spawning grounds in many different streams, although the Fraser River is their principal resort. They may be taken by hook and line in the Gulf of Georgia and Puget Sound during the winter. In February they are said to enter the Fraser River in small numbers, and they continue ascending during the succeeding months, becoming most abundant in May and June. A few are captured in connection with the sockeye, and later another definite run, somewhat smaller than the spring one, takes place: it begins in September and extends into October. The ordinary size of the species as represented in the catch is from 15 to 20 pounds, but individuals weighing 40 to 50 pounds, are not uncommon, and they have been taken weighing as high as 70 pounds.

Although the quinnat ranks desirably among the salmon of this region, it is not much utilized for canning purposes. In the spring, before the Atlantic salmon appears abundantly, it is in great demand and brings a higher price fresh for the eastern market, and subsequently small shipments continue to be made into the interior of the country. Furthermore, there are many light-coloured and even white-mottled fish among them, the proportion of such being some times very large, and causing prejudice against their use by the packers. The pound nets in United States waters are not set until after the close of the spring or main run and the catch in Puget Sound has consequently never been a large one.

Silver salmon.—The silver salmon, or "coho" of the Indians, is an active species, intermediate in size between the sockeye and the quinnat, which distributes itself widely through the region and enters even the narrower channels among the islands. It is said to afford excellent sport fishing in salt water. At Port Angeles, in the Strait of Fuca, it is expected to begin running in the early part of August, but about the San Juan Islands the first catches are made between the 20th and the end of August. In the neighbourhood of Seattle the earliest catch recorded in any year was obtained on August 28th, but the fishery for the species in that locality does not generally commence until about a week later, and it may be carried on until the latter part of October. On the Fraser River the run usually begins between September 10th and 15th, and continues through most or all of October. On this river the silver salmon is only utilized occasionally for canning, more especially in the event of a shortage in the catch of sockeye, but it is extensively salted there, and figures rather conspicuously in the output of the canneries in Washington, where the fishery is mainly by means of purse seines.

Humpback salmon.—The humpback salmon is the smallest and one of the most abundant species in these waters, but it is said to be present only in alternate years. The fish come in large schools and move very slowly, running mainly during August and the early part of September, but sometimes beginning in the latter part of July. They are often associated and taken in connection with the sockeye, but owing to their inferior quality are seldom made use of. In 1895 they were being canned at only one establishment, located in Washington. The Indians smoke them and they are also salted to some extent for export. This species spawns in the lower tributaries of the Fraser River and in many other coast streams.

Dog salmon.—This species comes next in size after the quinnat. It resorts to the fresh waters generally for spawning, entering, it is said, every little creek along the shores. There is considerable difference in the date of its first appearance in different parts of the region, but in Puget Sound the extreme range of the season is from about September 20 to the middle of November. In Hood's Canal it is taken earlier. In the beginning it is considered to be of good quality, but the colour of

the flesh is light, and becomes still paler as the season advances. The dog salmon has no commercial value on the Fraser River, but some of the Washington canneries make use of it, as do also the Indians.

Steelhead.—The steelhead or large sea trout are regarded as of excellent quality in this region, and are in demand for the fresh markets, but they have practically never been utilized by the canneries. Very little information could be obtained regarding their habits. They apparently run up stream mainly in the fall, but between what dates could not be learned. They are said to be in best condition from December to March, inclusive.

THE SALMON FISHERIES.

Fraser River.—Commercial fishing for salmon on the Fraser River has been carried on more or less extensively during about 20 years. It is restricted by law to tidal waters, the upper limit of which is placed at Whonnock Creek, some 40 miles above the mouth of the river. Drift gill nets are the only form of net permitted to be used for that purpose both here and elsewhere throughout British Columbia, with two exceptions, seines being allowed in one of the small northern rivers and trap nets in the Canadian part of Boundary Bay. Above the influence of the tide the Indians may take salmon for their own use by means of spears and dip nets, and hooks and lines may be employed.

The length of the drift nets is restricted to 150 fathoms. Two sizes of mesh are recognized. The larger, intended especially for the quinnat salmon, measures $7\frac{3}{4}$ inches in extension, and may be used from March 1 to September 15. The smaller, designed for the sockeye, silver salmon, etc., measures $5\frac{1}{2}$ inches, and may legally be employed from July 1 to August 25, and again from September 25 to October 31. In 1894, owing to the lateness of the run of sockeye, the open season for the small-meshed nets was extended to September 1. Between September 15 and 25, and between November 1 and March 1, all salmon fishing with nets is prohibited.

Drift net fishing is actually carried on only to a limited extent above the town of New Westminster, which is situated about fourteen miles from the mouth of the river. This is especially the case with respect to the sockeye, for which species only a small proportion of the nets are set above that place, to a distance of three or four miles, nearly all of the fishing being conducted in the lower part of the river and in the adjacent open waters. The outside grounds which have been much resorted to during the past two or three years extend from Point Grey, at the north, to the international boundary line at the south, and offshore a distance of five miles or more.

Until 1891, inclusive, the number of drift nets employed was limited to 500. Since then, however, licenses have been issued to all *bona fide* fishermen, British citizens and residents, who make application. The canneries and other establishments dealing in salmon are allowed several nets apiece, but each independent fisherman is entitled to only a single net. The number of drift net licenses issued and the total length of the nets employed each year since 1891 has been as follows:—

Year.	Number of Nets.	Total Length of Nets.
1892.....	702	123,250 fathoms.
1893.....	1,072	176,000 "
1894.....	1,666	250,000 "
1895.....	1,733	260,000 "

The licenses do not define the ground which each fisherman may occupy, but it is provided that the nets shall be kept at least 250 yards apart, and shall not be

used so as to obstruct more than one-third the width of the river. Fishing is carried on both day and night, the highly discoloured water which prevails throughout the fishing season serving to obscure the presence of the nets in the day-time.

We could obtain no definite information respecting the rate of movement of the sockeye up the Fraser River. A weekly close season is observed from six o'clock Saturday morning until six o'clock Sunday evening, immediately following which better fishing, as a rule, is obtained in the neighbourhood of New Westminster than at other times of the week. This fact would seem to indicate that fish are able to cover the distance from the mouth of the river in considerable numbers during the 36 hours of uninterrupted passage.

Coast of Washington.—In the Gulf of Georgia, Puget Sound and adjacent waters within the state of Washington, salmon fishing is carried on by means of trap nets, purse seines, drag seines, reef nets and gill nets.

The reef nets belong exclusively to the Indians, and are the original and principal method employed by them for taking salmon. They are fished among the kelp on rocky bottoms, especially about the San Juan Islands, Lummi Island and Point Roberts. The catch by this means, however, composes only a very small proportion of the total catch of the sound. Gill net fishing is followed to some extent in a few of the rivers.

Next to the trap nets, seines are the most productive of the appliances utilized in this region. Two kinds are employed, purse seines and drag seines, the former most extensively. The species chiefly obtained by these methods are the silver, hump-back and dog salmon. Of the total output of the Washington canneries, in 1895, about one-fourth of the fish, by weight, was secured by means of seines. More than one-half of the seine catch was packed at Seattle and no part of it at Point Roberts, but a small catch made in the vicinity of the latter place was disposed of on the Fraser River.

Trap nets have been found to be the most effective form of apparatus for the capture of the sockeye salmon in the clear open waters of the gulf and sound, but they are of recent origin in this region and are still employed in only a few localities, although the tendency is now to increase their number rapidly. Their use has thus far been almost entirely restricted to the zone traversed by the sockeye, and to the season when that species is present therein, but at times one or more of the other species may be taken in large quantities in conjunction with it.

The distribution and number of the trap nets in 1895 was as follows: Point Roberts, including two in the Canadian waters of Boundary Bay, 15; Village Point, Lummi Island, 2; Cattle Point, San Juan Island, 2; Point Demock, Camano Island, 1; Hunot Point, Fidalgo Island, 1; total 21. This is probably the largest number that has been fished in any one year. Additional locations have been occupied, but have been abandoned after trial, and more or less changes in position have everywhere taken place each season. Outside of Point Roberts the use of these nets does not seem to date before 1893, and the majority of those above enumerated were established in 1893 or 1894. We were informed that the building of at least 7 new ones in several different places was contemplated for 1896.

Trap net fishing has been carried on chiefly and for the greatest length of time in the waters immediately surrounding Point Roberts, where the sockeye salmon appear to strike in greater abundance than elsewhere near the shore in United States territory. There are about 32 trap net locations, so-called, in this region, that is to say, places where such nets have been constructed, but less than one-half of them were occupied in 1895. Experience has indicated the most favourable situations for operating traps and these have been taken possession of by those in a position to control the ground, while others have to be satisfied with inferior sites, and some experimenting is still going on in the hope of securing good results in other places.

Of the fifteen nets operated about Point Roberts in 1895, two were off the west shore, two off the south shore, and eleven off the east shore, the last being within the area known as Boundary Bay. The western traps were both situated near the

boundary line, the crib of one being nearly a mile, and of the other, nearly two miles offshore. The leader of the former approached near the shore, but that of the latter began a long distance off, on the edge of the wide bank or shoal. The two southern traps were located not far from the south-western corner or lighthouse reservation, the leaders starting near the beach, and the cribs being distant from the shore about 1,200 and 2,000 feet, respectively.

In Boundary Bay, the water is everywhere so shallow as to permit of a very general distribution of the traps, the most of which have been located without reference to proximity of the shore. In 1895, there was one continuous string of three traps and another of two traps, the remainder being arranged singly. The string of three traps extended off in a south-easterly direction from the south-eastern corner of the point, on which is located the only salmon cannery at this place, lying, therefore, at the entrance to Boundary Bay in rounding Point Roberts from the direction of Fraser River. Its entire length was about one mile; the inner end of the inner leader came close upon the shore, and at the time of our visit, was carried up to high water mark on the beach by an additional piece of netting. The passage of the salmon around this point is thereby prevented for the distance of a mile offshore, and navigation is likewise impeded to the same extent. This line of traps practically parallels the northern margin of a large rectangular reef or patch of rocky bottom, on which the Indians have hitherto done the main part of their reef net fishing for sockeye. The fish are thus mostly turned away from this once productive ground, and this fact has led the Indians to seek redress in the courts, on the plea that treaty rights have been violated.

The remaining 8 traps in Boundary Bay lie to the north and north eastward of the long string, as far as the boundary line, two, in fact, being north of the line, in Canadian waters. The majority of the traps in use, however, as also of the abandoned locations, are situated directly east of the southern part of Point Roberts, their trend, in a general way, being north-west and south-east, but varying considerably within those limits. The cribs of these nets are distant from low water mark on the nearest adjacent shore from about two-fifths of a mile to about two miles, the lengths of the leaders and the positions of the inner ends of the latter with respect to the land differing greatly.

The location and direction of all the traps about Point Roberts have been based upon such knowledge of the movements of the schools of sockeye as the fishermen have acquired through several year's experience. The best position of all is said to be that occupied by the string of three nets extending off from Cannery Point. Next in supposed order of excellence is the neighbourhood of south-west point, followed by the outer waters in the vicinity of the boundary line. The poorest success has been met with in the upper part of Boundary Bay. In some locations, considered to be advantageous as regards the movements of the fish, the bottom or other conditions are unfavourable for introducing this character of apparatus.

The arrangement of the traps is on the understanding that at least those schools of sockeye which pass near the shore enter Boundary Bay toward its eastern side, and then sweep around toward Cannery Point or the adjacent reef. Thence they are supposed to follow the southern and western shores of Point Roberts until near the boundary line, where they are deflected somewhat by the broad bank lying in front of the Fraser River mouths. The leaders are set so as to face the approaching schools and direct them toward the cribs, their course varying, therefore, more or less in accordance with their position. As the fish move only in one direction, passing in a general way from east to west, the cribs have an opening only on one side.

The cribs at Point Roberts are large, but vary considerably in size; they are rectangular in shape, but seldom exactly square. The smallest, in 1895, measured 40 by 38 feet, the largest 80 by 70 feet. Owing to their exposed position and the occasional heavy storms which occur during the fishing season, the trap nets have to be very strongly constructed and present the appearance of being built to stand permanently; but they are sometimes greatly damaged, and at the end of the season are all practically dismantled, although the stakes are seldom removed, being

generally left in place even when the site is abandoned. The depth of water at the cribs at low tide varies from 3 to $8\frac{1}{2}$ fathoms; at the inner ends of the loaders it ranges mostly from 1 to 3 fathoms, but three of the traps have no shoaler water about them in any part than 5 fathoms.

The first trap net at Point Roberts is said to have been established about 1885; a second one seems to have been added about 1888. The number was increased to 4 or 5 in 1890 or 1891, to 13 in 1893, and to 16 in 1894. The waters about the point have furnished profitable fishing to the Indians as far back as the records go, and during at least 10 years preceding the introduction of the traps, drag seines were used there by the whites, the catch of salmon made by this means being chiefly salted for shipment.

Canneries.—The canning of salmon on the Fraser River began about 1875, since which time the number of establishments engaged in that business has steadily increased, reaching 30 in 1895. These are mostly located at and below Ladner in the extreme lower part of the river, the principal centre for them at present being Steveston, at the mouth of the central or main channel.

In the United States waters of the region six canneries were in operation in 1895, one each at the following places, namely:—Seattle, established about 1878; Semiahmoo, 1890 or 1891; Point Roberts, 1893; Friday Harbour, 1894; Port Angeles, 1895, and Bellingham Bay, a small experimental cannery, built in 1895. The construction of several new canneries was contemplated for 1896.

Statistics.—Complete statistics for the output of salmon are available only for the Fraser River and adjacent Canadian waters. The following figures covering that district during the past four years are taken from the official reports:—

Year.	Canned Lbs.	Fresh. Lbs.	Smoked and Salted. Lbs.	Total. Lbs.
1892.....	4,277,552	2,047,009	916,000	7,240,561
1893.....	22,763,380	2,736,000	884,200	26,383,580
1894.....	17,451,172	1,250,000	380,000	19,081,172
1895.....	24,445,421			24,445,421

The output of the Washington canneries for 1895, based partly on estimates, was about 5,375,000 pounds, of which about 2,600,000 pounds were of sockeye canned at Point Roberts, Semiahmoo and Friday Harbour. No figures could be obtained of the sales of fresh and salted salmon taken in United States waters.

POLLUTIONS.

Fish offal.—In the dressing of salmon for canning purposes a very large quantity of waste is produced, amounting to at least one-third the total weight of the fish handled, and in some cases, by actual observation, to between 40 and 50 per cent. This waste consists of the heads, fins, tails and entrails, all of which are rejected, as no use for them has yet been found except in the manner described below. The proper disposition of this offal, aggregating many tons each season, has given rise to much discussion. The customary practice has been to dump it into the water near each of the canneries where it is produced, but several remedial measures have been attempted although none has met with satisfactory results. The question raised with respect to the presence of so much offal in the water is whether its effect is detrimental or not, either to the welfare of the salmon or to the health of the adjoining region. The bulk of it is produced within a comparatively short period of time, and hence the difficulty of caring for it otherwise than at present. The Canadian regulations of 1890 prohibit the throwing of the offal into the Fraser River, and at one time an attempt was made to have it carried out beyond

the mouth of the river, but this measure was found to be inexpedient and has not continued to be enforced. Factories have been established for converting the waste into oil and fertilizer, but not meeting with financial success they were soon abandoned. This subject has received no attention from the state authorities of Washington.

The cannery people everywhere are confident that no harm results from their method of disposing of the offal, unless it be in certain restricted areas where the eddies cause its retention for a time. During the greater part of the canning season the volume of water in the Fraser River is large, its temperature is low and the current strong. The offal in a fresh condition is said to sink at once and to disappear. The inhabitants, generally, along the river oppose the practice on the ground that it is injurious to health, from which standpoint, however, the question is not of international significance. With respect to the open waters of the sound, we have heard of no complaints regarding this matter, although some of the offal is known to wash ashore in places.

No evidence has been obtained which shows that the throwing in of the offal has had a pernicious effect upon the movements or the abundance of the salmon. If such an effect has actually been produced, as may be the case, it has not, up to the present time, made itself sufficiently manifest to bring it within the scope of observation. We are led, however, to deprecate the continuance of the practice for local reasons at least, and would urge further experiments looking to the utilization of the offal as an incentive to its retention on land.

REGULATIONS IN FORCE.

Following are the more essential provisions of existing salmon regulations on both sides of the boundary line, and also of certain proposed enactments by the Legislature of the State of Washington.

Fraser River.—Commercial fishing is restricted to tidal waters, and to the use of drift gill nets not exceeding 300 yards in length.

The drift nets for quinnat salmon shall have not less than $7\frac{1}{2}$ -inch mesh, and may be used from March 1 to September 15.

The drift nets for other kinds of salmon shall have not less than $5\frac{1}{2}$ -inch mesh, and may be used from July 1 to August 25, and again from September 25 to October 31.

All commercial fishing is prohibited weekly from 6 a. m. Saturday to 6 p. m. Sunday; and annually from September 16 to 25, and from November 1 to March 1.

Drift nets shall be kept at least 250 yards apart, and shall not obstruct more than one-third the width of the river.

Salmon weighing less than 3 pounds shall not be taken.

Resident fishermen are entitled to 1 license each; cannerymen and dealers in fresh and prepared salmon, to from 2 to 20 licenses each.

Washington.—The only regulations relating to the capture of salmon in the open waters of Puget Sound are as follows:

No trap net lead shall exceed 2,500 feet long. There shall be an end passageway of at least 600 feet, and a lateral passageway of at least 2,400 feet between all traps, set nets, etc.

A license is required for each fixed appliance and not more than three licenses shall be issued to one person or corporation. Licenses are issued only to residents and citizens of the state.

Salmon measuring less than 10 inches long can be taken only by hook and line.

By a recent decision of the court, the waters about Point Roberts were declared to be outside of Puget Sound, and, therefore, not subject to the above provisions. There are, consequently, no restrictions applicable to the fisheries in that locality, and this condition was sought to be remedied by a bill submitted to the State Legisla

ture in February, 1895, which passed the House, but failed of action in the Senate. The following were the principal features of the proposed bill:

The area covered was defined as Puget Sound and the Gulf of Georgia and their tributary waters, within which the same system of licenses should maintain as in the existing law.

Trap net leads were limited to a length of 2,000 feet, with an end passage-way of at least 600 feet and a lateral passageway of at least 3,000 feet between all traps. The mesh of the nets were to measure not less than three inches in extension, and all stakes were to be removed within thirty days after the close of the fishing season.

A close season was provided for the open waters during the entire month of October, and for tributary streams during April, and from October 1 to November 15. In the fresh water tributaries only hook and line fishing was to be permitted between sunset Saturday and sunrise Monday of each week.

The throwing of mill refuse into the water was prohibited.

SUMMARY OF CONDITIONS.

The purely salt water fisheries of the Gulf of Georgia, Puget Sound and adjacent waters have so far been only slightly developed, a comparatively little is known respecting the extent and distribution of their resources. In view of this fact, and until the region shall have been more thoroughly studied and its requirements more definitely ascertained, we consider it inadvisable to attempt their regulation.

The salmon fishery, on the other hand, presents important questions demanding urgent attention. Each of the six species of salmon resorting to these waters has a commercial value and is utilized, although to a variable extent, dependent in part upon the popular estimate of the quality of its flesh and in part upon the readiness with which its capture may be effected. There is no evidence up to the present time of a decrease in the abundance of any of these forms, but the fishery already conducted on a large scale, is growing rapidly, with the prospect of its resources soon becoming overtaxed in at least one direction.

Five of the species have more or less widely distributed spawning grounds, which circumstance favours their chances of preservation and makes their protection feasible to some extent by local measures. The sockeye salmon, however, having its spawning grounds mainly confined to a single river, toward which the movement of successive schools is chiefly directed on their passage from the sea through the inclosed salt waters of the two countries, constitutes the most prominent object of the fisheries for international consideration at the present time. From a commercial standpoint, moreover, this species is much the most important member of the salmon group in these waters, and were its distribution sufficiently extensive and its season sufficiently prolonged, it would probably be the only species made use of by the canneries.

The perpetuation of the run of sockeye, as of the other salmon, depends unquestionably upon a sufficient number of the fish reaching their spawning grounds annually to provide for the quantity withdrawn by the nets. As regards the sockeye, the material interests of the Fraser River and of the coast of Washington are identical, and whatever might affect the fishery disadvantageously on the one would be equally harmful on the other.

Much remains to be learned respecting the movements of this species. It appears certain that the schools bound for the Fraser River divide or separate when they reach the inner end of the Strait of Fuca, a part passing up to the westward and a part to the eastward of the San Juan Islands, but they are said to entirely avoid the central or San Juan Channel, possibly on account of the very shallow water at its southern entrance. Some of the schools enter Boundary Bay and, thence, turning to the westward, make around Point Roberts, the site of the principal fishery in United States waters. It has not been ascertained by observation, however, what proportion of the fish reach the neighbourhood of Point Roberts, and

there is a diversity of opinion on that subject. The weight of the evidence favours the belief that a large, if not the larger, proportion of the sockeye, after entering the Gulf of Georgia, make directly for the Fraser River or, at least, reach its mouth without approaching closely to the Washington coast. This is supposed to be especially the case with those passing through the Canal de Haro, and this view is supported by the fact that the drift net boats from the river obtain their best fishing well out in the gulf. The fishermen at Point Roberts claim, moreover, that the schools which come their way trim the shore only in part, being distributed to a distance of three or four miles off the land, and that, therefore, only a certain proportion of the fish can be intercepted by the trap nets. The fish are also said to enter Boundary Bay no further than half a mile above the boundary line, and in passing out of it to strike mostly at the south-east and south-west corners of the point, which furnish the best fishing situations. They evidently do not tarry long in Boundary Bay or about the point, as all accounts agree that they are moving rapidly toward their destination. They appear, however, to collect and remain for a short time in the discoloured and brackish water, which, at the season of their passage, covers the broad shoal off the mouths of the Fraser River and makes it such an attractive ground for the drift net fishermen.

To what extent fishing for the sockeye can profitably be carried on south of Point Roberts is still problematical. In the Strait of Fuca the species is first seen abundantly in the vicinity of Beecher Bay, where the conditions seem unfavourable for extensive operations. It is next observed at the southern end of San Juan and Lopez Islands, where Indian reef net grounds occur and where two trap nets have been fished during two years past. Small quantities are taken in the traps in Skagit Bay, which they enter through Deception Pass, but of the northward moving schools the third principal fishing ground is on the outer side of Lummi Island near its northern end. Other reef net grounds about the San Juan Islands may be known to the Indians, but the only places where trap nets have been used at all successfully are those just mentioned.

The fishery in United States waters, however, is of very recent origin, and the incentive to its development is so great that we cannot doubt the early discovery of means for intercepting the schools at numerous places along their course. In this view of the case, which we feel entirely justified in taking, it is important that suitable protective measures be established at once, while the supply of salmon is still intact and its maintenance can be assured. In framing our recommendations much difficulty has been encountered in consequence of the great diversity of conditions and practices prevailing on the two sides of the line, but we have sought to provide as uniform regulations as the circumstances render possible. The discoloured waters of the Fraser River are best suited to the use of drift nets. In the open, clear waters of the state of Washington, however, trap nets furnish the only means known to be adapted to the capture of the sockeye on an extensive scale, only a relatively small quantity of this species being taken in the Indian reef nets and the drag seines. The principal interests requiring to be harmonized, therefore, are those of the drift nets and the trap nets, appliances which are totally unlike in their working and in their requirements. Not permitting of a comparison of their respective merits under the different conditions which here accompany their employment, the only safe expedient has been to provide for the passage toward their spawning grounds of a certain proportion of the fish, both by maintaining open passage-ways at all times, and by the removal of all obstructions at stated periods. These measures have been adopted as the main features of the regulations herewith suggested.

RECOMMENDATIONS.

1. The following recommendations are intended to apply only to those waters, adjacent to the boundary line between British Columbia and the state of Washington, which are traversed by the main body of the sockeye salmon and to which our inquiries were chiefly restricted. This area may be roughly defined as comprising

the Strait of Juan de Fuca and those parts of the Gulf of Georgia and Puget Sound (Washington Sound) lying between the parallels of $48^{\circ} 10'$ and $49^{\circ} 20'$ north latitude, together with their adjacent bays and tributary streams. We consider, however, that it would be advantageous to extend the scope of any joint regulations which may be agreed upon to all parts of this inclosed sea, and the information necessary to accomplish that purpose satisfactorily could readily be obtained.

2. In the salt waters comprised within the state of Washington we see no reason for prohibiting at present any of the kinds of apparatus now employed there, namely, trap nets, purse seines, drag seines, reef nets and gill nets, the bulk of the sockeye catch being made in the form of net first mentioned.

3. We are in accord with the Canadian regulation which restricts commercial fishing on the Fraser River and off its mouths to the use of drift gill nets, and recommend that the rivers in Washington be subject to the same regulation.

4. Being uncertain as to the capacity of the contiguous waters in question in respect to fishing operations, we are not prepared to suggest a direct limitation upon the quantity of apparatus to be employed, but consider that the present requirements of the case will be met by the restrictive measures which follow.

5. The mesh in trap nets to measure, in extension, not less than three inches in the crib and 6 inches in the leader when actually in use.

Trap net leaders not to exceed 2,000 feet in length.

Not more than two traps to be placed in one continuous line, and when so arranged to be separated by a gap of at least 100 feet between the inner crib and the beginning of the outer leader.

All traps or strings of two traps to be separated by lateral passage-ways of at least 2,500 feet.

The inner end of all trap net leaders to begin in a depth of not less than 1 fathom at low tide, and the space intervening between it and the shore to remain entirely unobstructed.

All trap net stakes to be removed from the water, in the interest of navigation, within 30 days from the close of the fishing season.

6. Drift gill nets not to exceed 150 fathoms each in length.

The drift gill nets employed for taking quinnat salmon to have not less than $7\frac{1}{2}$ -inch mesh extension measure, and to be used only from April 1 to September 15.

The drift gill nets employed for taking the sockeye and other smaller species of salmon to have not less than $5\frac{1}{2}$ -inch mesh extension measure, and to be used only from July 1 to October 1.

All drift nets when in use to be kept at least 250 yards apart, and to obstruct not more than one-third of the width of the river.

7. We are not prepared to suggest any changes in the dimensions or in the manner of employing drag seines, purse seines and reef nets, nor do we consider any such changes essential while the extent of fishing by these methods remains as small as at present.

8. It is recommended that in all rivers commercial fishing with nets be restricted to the tidal part of the river.

9. We consider it very important that the movement of the salmon toward their spawning grounds be facilitated by weekly close times of 36 hours duration, which we suggest extend from 6 a.m. on Saturday to 6 p.m. on Sunday of each week, during the continuance of the fishing season.

10. We also recommend an annual close season, extending from October 1 to April 1 of each year, during which all net fishing shall be prohibited.

11. We recommend that the Indians be allowed to fish at all times by their customary methods, except the use of drift nets and spears on the rivers during the close seasons, during which periods, moreover, they should be permitted to take salmon only for the purpose of supplying themselves with food, and not for sale or barter.

12. As no evidence of a decrease in the abundance of any of the salmon species has been obtained, we do not feel justified in recommending joint action at present in the matter of their artificial propagation. While we feel confident that the

natural supply can best be maintained by early compliance with suitable protective measures, we found it generally admitted that the efforts made by the Canadian Government to increase the stock of sockeye salmon on the Fraser River by fish-cultural methods has been beneficial, the annual run of the fish being made more constant and the off seasons being improved. In view of the growing demand for the shipment of quinnat salmon in a fresh condition, which may sooner or later come to exceed the supply, we venture to suggest the possibly greater advantages to be gained by the artificial hatching of that species.

13. We are convinced that the remedial measures which have heretofore been adopted, although not enforced, for disposing of the fish offal from the canneries on the Fraser River are inadequate to accomplish the results intended and are also to a large extent impracticable. The practice of throwing this waste material into the river is to be deprecated on general principles, but except in respect to a few localities, no specific evidence has been presented to indicate that it may be detrimental either to the health of the community or to the welfare of the salmon, and there is no proof that the latter have suffered from this cause. It seems to us that as much, if not greater, harm would result from dumping the offal in the open waters off the entrance to the river as from its disposition in the customary manner in the vicinity of the canneries, providing the necessary precautions are taken. So far as we have been able to ascertain, when thrown into the current of the river in a fresh condition it is practically always dissipated, and produces a nuisance only when placed in quiet, shallow water or in eddies which tend to retain it along the shores or to carry it into the adjacent sloughs. Factories established for converting it into oil and fertilizer have failed of success, nor is there any apparent prospect of its extensive utilization in the immediate future. While suggesting renewed inquiries for reaching a more satisfactory solution of this question, we are constrained to recommend that, for the present, the current practice be allowed to continue, under such restrictions as may be called for to prevent the accumulation of the offal in any situations where its effect can be shown to be prejudicial. The fishery officer of the district should be empowered to designate all places where the throwing in of this waste should not be permitted.

No complaints respecting the offal in the vicinity of the canneries in the state of Washington have been received from any source, nor do any regulations regarding the manner of its disposition in that region seem to be called for at present.

14. Waste from saw-mills and other substances deleterious to the salmon should not be allowed to pass into any streams which they frequent.

WM. WAKEHAM,

Representative on behalf of
Great Britain.

RICHARD RATHBUN,

Representative on behalf of the
United States.

City of Washington, December 31, 1896.

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